The GIUZ Australia 2016 excursion – Travel report

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The GIUZ Australia 2016 Excursion

Travel Report

January 17 – 31, 2016

Remote Sensing Laboratories RSL
Department of Geography
University of Zurich, 2016

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Remote Sensing Laboratories RSL

Department of Geography

University of Zurich, 2016

Itinerary

Over 5'000 km from Perth to Adelaide

Excursion day reports

Background information

Preface
The making of an excursion – stories behind the GIUZ Australia 2016 adventure

Mathias Kneubühler

Why are you offering an excursion to this part of Australia? Why do you start in one of the remotest cities of the world (by the way, Perth has nevertheless more than two million inhabitants…)? Why don't you visit the real attractions of Australia, such as Uluru, Sydney, The Gold Coast or Kakadu NP? How about snakes, scorpions and spiders? And then for God's sake, why will this excursion to the hottest areas of Australia take place in the middle of their summer?

These were some of the questions we were frequently confronted with and we realized it might be a good idea to be prepared with convincing answers to them.

The idea of organizing an excursion to Australia for students actually developed rather spontaneously over a few beers at the Country Club in Kununurra, a sleepy town far up north in Western Australia (WA) on a hot and humid day in July 2013. Andy and myself had just concluded our travels on the Gibb Road across the Kimberleys in WA after escaping a cold and rainy week in Melbourne, where we attended the 2013 IGARSS event. The Country Club in Kununurra is actually the only place in town where they serve beer, with sale and supply of alcohol in WA being governed by a very strict liquor control act. It was there that we made first plans of our excursion. Although we had numerous contacts of colleagues and institutions across Australia that could potentially be visited during an excursion, our excursion would have to start in WA: West is best! we were sure, since we love sparsely populated areas, gravel roads, outdoor camping, open skies and semi-arid landscapes.

Well, these locations are not really close to each other…

It was at the IGARSS conference dinner back in Melbourne where we met Travis and Davina, the two experts on aquifer ecosystem research in the Great Artesian Basin of Australia. Their stories about the wonders of Dalhousie Springs at the border of the Simpson Desert in the north of South Australia undoubtedly convinced us that this remote region is definitely worth being visited on an excursion with students.

And then for God's sake, why will this excursion to the hottest areas of Australia take place in the middle of their summer?

The research in remote sensing for mineral mapping being performed by colleagues at CSIRO in Perth that we have been collaborating with for several years was to be another corner point of our excursion.

While on a Jetstar service flying from Kununurra back to Perth in 2013, I was by chance sitting beside a guy working in the WA mining industry. He insisted that whenever we realize a future excursion to Australia, it has to pass via the famous mining city of Kalgoorlie for good reasons.

With this, Andy and myself ended up with a first rough excursion plan: our trip had to include Perth and Kalgoorlie in WA and the Great Artesian Basin in South Australia (SA). Well, these locations are not really close to each other… Options including the Indian Pacific Great Southern Railway or domestic flights turned out to be unrealistic due to schedule and flexibility. Why not go for a convoy of 4WD cars and drive the 5000 km, including the famous longest straight road across the Nullarbor Plain? At last, it shall be an excursion for geographers and it turned out that cars would serve best our aims to encounter beautiful landscapes, outdoor adventures and camping as a group!

Shortly after returning to Zurich from that 2013 trip to Australia, Andy and myself sat together at the Oliver Twist Pub and we wrote a first version of an excursion proposal to be submitted to the GIUZ directorate. The proposal contained a scientific and a financial part and was submitted soon after. It was well received by the directorate and it even seemed as if no one else at GIUZ had planned a big excursion in 2015! Well, all of a sudden, ideas for an excursion to Sri Lanka materialized and we were gently offered to plan our Australia excursion for 2016. With this, we now had plenty of time to fine-tune our excursion proposal and to plan a decent seminar with the students prior to the travel. Flyers and digital announcements were out by March 2015, allowing students to apply with a motivation letter by mid May. The excursion was now scheduled for January 2016. January? This is the hottest time you can choose to go to this part of the world! True, but some good reasons like summer in winter, dry season and, last but not least, semester and exams schedule, let us decide that way.

And this is the story the GIUZ Australia 2016 excursion report at hand tells us now.

Would there be any interest in our excursion? If yes, how many students would apply? Would they comply with our rigid selection criteria: being flexible, uncomplicated, interested, loving the outdoors, camping, cooking, heat, flies, dust, long drives on gravel roads, travelling as a team and of course, being interested in the excursion's main scientific goals: remote sensing and geosciences, mineral resource exploration, satellite calibration & validation, and aquifer ecosystem research. Very early during our preparation seminar in autumn 2015, it turned out that the ten best students (and two RSL staff) we could wish for had applied for the trip and were successfully selected!

The excursion preparation seminar took place on a bi-weekly basis. During the first meeting, the students realized that this will actually be *their* excursion. Andy and myself had a good idea of who and what we are going to visit along the road, but detailed planning was essentially the task of the seminar in the weeks to come. And there was a lot to plan: Twelve topics needed detailed consideration, including organizational issues like travel schedule, route, distances, camp sites, food supply points, bottle stores, gasoline, food concept, water supply, shopping lists, cooking strategy, regional scale info, daily hotspots along the road, first aid, medical points, annoyances and hazards, gear lists, travel space in the cars and excursion documentation. Besides that, information concerning the excursion's scientific goals needed to be compiled, including mineral resources, mining, history, politics, aboriginal lands, natural resources, national parks, economy, remote sensing and GIS organizations, satellite data, etc. etc. Progress on all these topics was regularly reported during the seminar, which gathered an incredible momentum from the early beginning on. Everyone was extremely motivated and our excursion became perfectly shaped to its very details.

December is always a very busy month with the autumn semester coming to an end and module exams coming up right before and after Christmas. Many late hours were spent in order to finalize all necessary details for the big excursion becoming now imminent. The date was set: 17 January 2016 was the day when we will all meet in WA! Even with a thoroughly planned excursion, day-to-day management remains an important aspect of an adventure like ours. And this is the story the GIUZ Australia 2016 excursion report at hand tells us now.

THANK YOU to everyone who was on board – you were a great team!

Excursion leaders

Mathias Kneubühler
PhD in Remote Sensing
Research interests include imaging spectroscopy, spectro-directional, multi-angular measurements and data analysis, ecosystem monitoring and phenology, and related field work.
Prefers sparsely populated, natural landscapes to urban areas and enjoys being on the move, encountering the little highlights, exciting stories and good memories along the route.

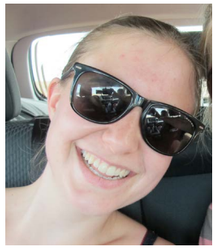
Andy Hueni
PhD in Remote Sensing
Specialised in imaging spectrometer calibration, data processor development, aircraft mission planning and operations, field spectroscopy and spectral database development.
Likes to be outdoors whenever possible, enjoys basic living conditions and the interesting little challenges that present themselves everyday on the road.

Drivers

Daniel Henke
Research associate for dynamic processes in remote sensing data, with special focus on radar technologies.
Interested in nearly everything as long as it has to do with sports activities and sunshine in one way or another.

Christoph Rohner
PhD student investigating the flow dynamics of glaciers using Synthetic Aperture Radar satellites and a ground-based radar system.
Passionate cyclist that likes to conquer challenging routes and climbs.

The lucky group of participating students



Sandra Roth
Specialized master student in remote sensing with a bachelor background in history, politics and geography.
Ready for outdoor adventures and our reliable food and kitchen manager.

Tobias Klee
Master Student in remote sensing with a bachelor background in political science.
Adapted the lifestyle of koalas during the excursion (sleep-eat-sleep).

Luca Scherrer
Specialized master student in GIScience. Interested (among a great range of other things) in mobility in an urban context and data analysis.
Responsible for tour and accommodation planning.

Joan Sturm
Bachelor student with minors in environmental studies and climate sciences. About to start a specialized master in remote sensing.
One of our devoted and skillful photographers in Australia.

Melanie Graf
Master student in geography with focus on physical geography and GIS. Very interested in experiencing the different Australian landscapes as well as hearing about the remote sensing challenges posed by it.

Fabienne Maag
Master student with a bachelor background in geography and minor in atmospheric and climate science. Interested in combining remote sensing with physical geography and ready for travelling anytime to any place.

Sonja Bertschi
Bachelor student in geography with special interests in geology and planning to start the master studies in remote sensing with additional focus on GIS and earth systems sciences.

Dominic Fawcett
Specialized master student of remote sensing with interests in imaging spectroscopy of vegetation.
One of our devoted and skillful photographers in Australia.

Franziska Moergeli
Geography Master student with a minor in environmental and climate science. In love with nature, sun and Australia, and in charge of first aid.

Sondra Tjin
Master student with emphasis on human geography having a special interest in the interaction between society and the environment. Likes to explore faraway places.

The GIUZ Australia 2016 excursion starts in Fremantle

Day 1, 17 January 2016

Mathias Kneubühler

Hurray! Our big Australia excursion finally starts today! After several months of preparation work during the autumn semester seminar, we meet at Fremantle railway station at 2 pm. Everybody arrives to Fremantle in Western Australia individually, either by train or by bus from close-by Perth. Some of us have already been in Australia for a few days prior to the excursion, others have just arrived the night before, either directly from home or after a stopover somewhere in Asia and therefore experiencing symptoms of a more or less severe jetlag.

It has been raining heavily in some parts of inner Australia and roads may be subject to closure at a daily basis.

Anyway, our campsite at Woodman Point Holiday Park in Fremantle is beautifully situated close to the Indian Ocean shoreline and some of us go for a well deserved swim after having successfully set up camp.

During a first get-together, Andy gives some further insights into the excursion programme of the next two weeks.

It is by now that the participants realize that the excursion will feature many aspects of an expedition. It has been raining heavily in some parts of inner Australia and roads may be subject to closure at a daily basis.

Fig. 1: Andy visualizes the main activities and points of interest of the Australia excursion while everyone enjoys a first welcome drink (Photo M. Kneubühler)

Fig. 2: Start of the Australia excursion with group dinner at the Little Creatures Fremantle Brewery (Photo M. Kneubühler)

As a consequence, our journey across the Nullarbor and into the central region of the Great Artesian Basin may be affected by changing short term scenarios and "Plan B's" in addition to cruel sun, heat and flies.

In the evening, we venture into town for a first tasty dinner and are lucky to grab a large table at the well frequented Little Creatures Fremantle Brewery right at the waterfront. A late stroll along Fremantle's many ice parlor places lets us experience the relaxed atmosphere of this popular historic seafront city on a weekend summer evening.

Fig. 3: Tents and convoy of four cars are still clean and properly arranged on the first evening of the excursion (Photo S. Bertschi)

Fig. 4: Perth Central Business District (Photo S. Bertschi)

Fig. 5: Preparations for a high standard outdoor group kitchen (Photo M. Kneubühler)

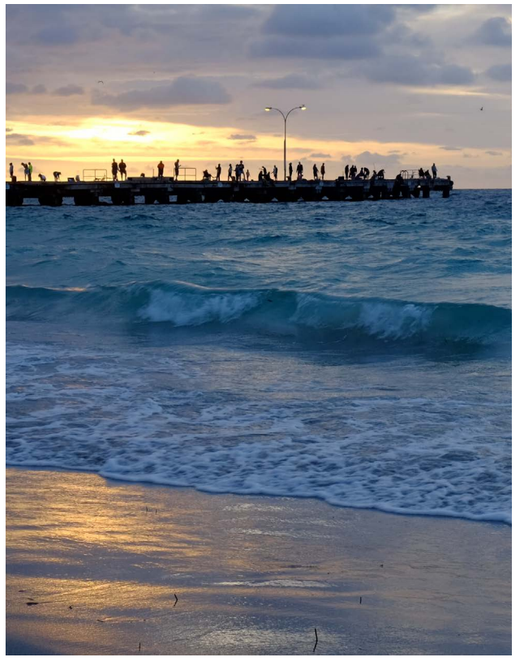


Fig. 6: Sunset after a relaxing swim in the Indian Ocean at the nearby beach south of Fremantle (Photo S. Bertschi)

Visit at CSIRO and Curtin University

Day 2, 18 January 2016

Andy Hueni

Monday was to be a day packed with information. We had a fairly easy start in the morning as the camp did not need breaking that day.

CSIRO Visit

We arrived at the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in Kensington (WA) early enough to get everyone signed in, grab their visitor badges and head for the cafeteria for some much needed intake of caffeine.

Our host Cindy Ong then ushered us into a meeting room with very comfortable chairs and we were given an overview about the work that is carried out in her group, focusing on the remote sensing of mineral resources.

The range of activities includes hardware engineering for sensors in the visible (VIS), shortwave infrared (SWIR) and thermal. A prime example of combining all these technologies is the HyLogger system, which is used for drill core scanning and analysis. We were scheduled to have a live presentation of the HyLogger that very afternoon, which would make matters more tangible.

We were introduced to further activities of the team, such as the development of software for spectral sensing applications and to the applied research topics of mining, exploration as well as rehabilitation and pollution monitoring. The latter subjects were pointing towards the darker side of the mining industry, which are frequently glossed over in the interest of cash flow to Australia and to Western Australia in particular.

Fig. 7: The excursion with our hosts (from left to right): Tom Cudahy, Cindy Ong and Ian Lau; in front of an artful compilation of various rocks found in Australia (Photo A. Rodger)

The HyLogger

Andy Hueni

The HyLogger has been developed by CSIRO's Mineral Mapping Technologies Group. It employs a number of sensors to semi-automatically measure drill cores. Two spectrometer systems provide continuous visible and infrared spectroscopy (wavelength range 300-2500 nm and 6000-14500 nm), digital imaging acquires true colour images of the cores while a laser creates a profile to detect any breaks in the cores [1]. These data are then used to identify and characterize minerals. The HyLogger can scan between 250 m and 500 m of core length per day [2]. In this manner, virtual drill cores can be assembled, such as the Auscope National Virtual Core Library (NVCL) [1].

The resulting data can be analysed in The Spectral Geologist (TSG) software [3]. This presents the data in a stunning way with a true colour representation of the core allowing an easy scrolling along the core where each spot can be investigated spectrally and a large variety of further panels give the estimated mineral composition throughout the core.

Fig. 8: The development model of the HyLogger is put through its paces, scanning a calibration tray representing three cores with known materials (Photo J. Sturm)

Fig. 9: : Example of a visualisation of an entire virtual drill core [1]

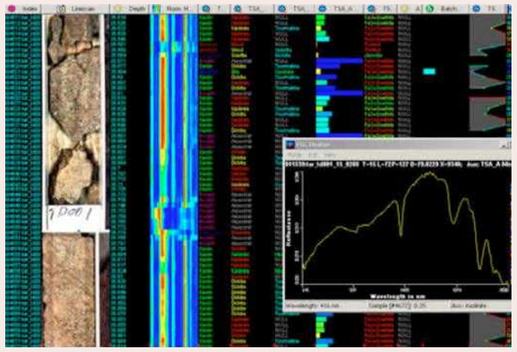


Fig. 10: Example of the TSG software; showing a visible picture of the scanned core (left), a spectrum at a particular position of the core and intricate details of extracted mineral compositions [2]

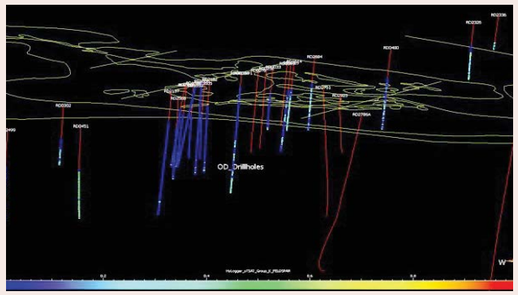


Fig. 11: Three-dimensional representation of drill holes scanned with HyLogger™, showing the relative distribution of K feldspar in the cross section [4], acquired at the Olympic Dam mine in South Australia

References
[1] publications.qld.gov.au/storage/f/2014-05-30T01%3A52%3A23.599Z/hylogging-core.pdf
[2] www.minerals.statedevelopment.sa.gov.au/geoscience/geoscientific_data/hylogger
[3] www.thespectralgeologist.com
[4] www.minerals.statedevelopment.sa.gov.au/geoscience/geoscientific_data/hylogger/olympic_dam_hylogger_data_release

One example of monitoring was the estimation of dust on vegetation using field sampling and applying it to imagery to get maps of dust pollution by mining activities.

A further topic that was dealt with in detail was the vicarious calibration of satellite sensors. We were given a rather comprehensive list of attributes that an ideal vicarious calibration site should feature:

- spatial, spectral and temporal stability conditions
- bare ground
- high albedo

To this end, a search for the ideal sites was conducted using the Landsat archive. This resulted, in addition to the already existing Lake Lefroy, in sites in the central Australian desert and some place near Exmouth.

It would appear that the ideal site is hard to find; salt lakes were suboptimal in SWIR due to their water content, sandy beaches mostly too small with too high aerosol, and inland dunes quite good, but difficult to access.

It was however with wonder that we heard that the whitest sands were to be found in Esperance (WA), with a staggering 80% reflectance!

We then had a look at the Australian mineral map derived from ASTER and Tom Cudahy took us through the intricate details of alteration zones, mineralogy and deposits. It was rather astonishing to seem him switch frantically from one slide to the next in his enthusiasm to show us the various features and proofs that this method was superior and could really map what was going on under ground!

We had a well-deserved lunch after this packed block of presentations. We dared to use the terrace outside of the cafeteria, but felt that clearly one could wish for a warmer climate, as the day was overcast and almost cold!

In the afternoon we visited a calibration laboratory, that was cramped and packed with installations, but featured the gear to calibrate field spectrometers and a dark box to measure samples. We then had a glimpse of the Brugger lab spectrometer systems and a microscope for the spectral analysis of micrometer sized sample sizes.

The major attraction, however, was the Hylogger demo, where a sample tray was scanned by an automated bench moving in two dimensions and the software producing an instant mineral analysis of the rocks present on the tray!

Next to the Hylogger room was a facility where a crew of people was occupied with meticulously cataloging and labelling a large number of rocks that had just been delivered to the lab.

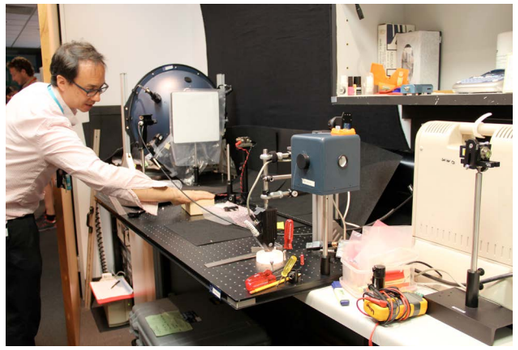


Fig. 12: Ian Lau presents the CSIRO optical calibration laboratory featuring integrating spheres, line lamps and doted materials (Photo J. Sturm)

The visit at CSIRO was rounded off by an introduction into the IGSN, standing for International GeoSample Number. This was a new standard to be applied to mineral samples and was to be the equivalent of what the ISBN is for books and the DOI for electronic documents.

Curtin University Visit

Our afternoon was continued at Curtin University where we got a general introduction to the types of research the remote sensing group was up to.

We also got a new and, for Swiss students, uncommon aspect, which was the remote sensing of aquatic systems.

Mark Broomhall led us through the presentation with his typical laid back and entertaining nature, ensuring that no one fell asleep.

It was however with wonder that we heard that the whitest sands were to be found in Esperance (WA), with a staggering 80% reflectance!

We learned with astonishment about the Southern Ocean Observatory, a massive, manned buoy that was supposed to drift in the Southern Ocean to take measurements.

A new Australian Research Council (ARC) project was going to investigate the mapping of phytoplankton (chlorophyll), which was said to be biased at the moment.

Also of interest was the imaging hemispherical filter radiometer, a type of a cosine receptor imaging a hemisphere of incoming light at several wavelengths.

We then heard about hyperspectral imaging of Shark bay (http://www.sharkbay.org.au) and were told to go there and see it for ourselves. Of particular interest were the stromatolites, one of the oldest life forms on Earth.

Mark also touched on the Terrestrial Ecosystem Research Network (TERN) AusCover super sites, which was interesting as we were going to get in the vicinity of one when we would drive to Kalgoorlie the day after.

Marine research using remote sensing at Curtin University

Andy Hueni

The Remote Sensing and Satellite Research Group at Curtin University [1, 2] has obtained an enhanced focus on marine remote sensing with Prof. David Antoine joining the research team. Consequently, the list of ocean related research topics includes:

- Ocean Colour
- Ocean Wave Spectra
- Sea Surface Temperature
- Ocean Heat Flux
- Coral Reef Management

One example involving airborne imaging spectroscopy was a mapping of the Ningaloo Reef Marine Park in 2006. These data have subsequently been used to map both the depth of water as well as the benthic cover at a spatial resolution of 3.5 m and up to depth of 20 m. The Ningaloo area hosts a spectacular range of marine life, including whale sharks (Fig. 15) and manta rays [3].

A more recent example is the imaging of the Shark Bay in 2011, with three different airborne sensors: AISA Eagle Hyperspectral instrument, LIDAR and digital photography. Additionally, data were collected from boat and terrestrially, employing echo sounders and field spectrometers.

The same area was again studied in 2012 using the HICO imaging spectrometer mounted on the international space station. These data were used for change detection within the waters of the bay, influenced by tidal streams (Fig. 14).

Fig. 13: Mark's entry slide jerks everyone awake with its stereotypic but somewhat refined impression of Australia (Photo M. Kneubühler)

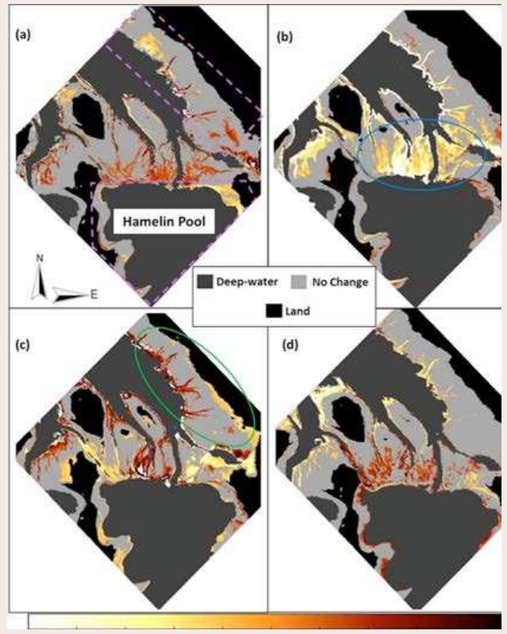


Fig. 14: Depth change maps for four different dates in 2012, produced from HICO data [4, 5]

Fig. 15: Whale shark at Ningaloo (Photo A. Hueni & Ningaloo Reef Dive)

References

[1] remotesensing.curtin.edu.au/research/

[2] remotesensing.curtin.edu.au/research/streams.cfm

[3] en.wikipedia.org/wiki/Ningaloo_Coast

[4] hico.coas.oregonstate.edu/meetings/HICOThirdUsersMeeting2014/04_McKinna_HICOMeeting2014.pdf

[5] Garcia, R. A. Fearns, P. R. C. S., & McKinna, L.I.W. (2014). Detecting trend and seasonal changes in bathymetry derived from HICO imagery: A case study of Shark Bay, Western Australia. Remote Sensing of Environment, 147C, 186-206

Freo to Kalgoorlie

Day 3, 19 January 2016

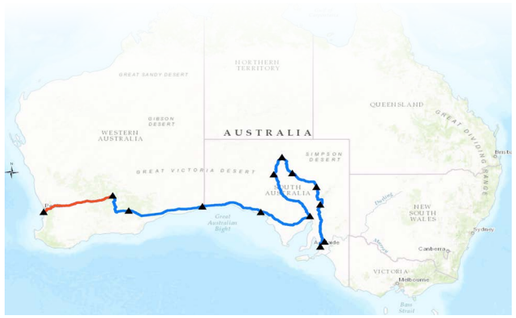
Franziska Moergeli

Our very early and rather comprehensive breakfast, containing scrambled eggs, bacon or self-made Birchermüesli, took longer in preparing than eating. For the ones (like myself) not suffering from jet lag anymore, getting up at 5.30 a.m. was rather hard and we were the ones being last at finishing breakfast and wrapping our tents. But we managed as well sitting in our four cars at 8 a.m. (even if with a very sleepy face) so we could leave the west side of Australia and begin our journey eastwards to Adelaide along the Great Eastern Highway (590 km).

Fig. 16: Beginning of an awesome journey. As Mr Henke points out, he has car Number 2 (Photo F. Moergeli)

Choosing a car turned out to be a funny game as well as an important ceremony every morning. Over the next two weeks we tried to mix and change seats so no one had the same driving partners twice. This turned out to be a wise decision because only today we drove for over 600 km, taking us almost the whole day. So by that evening, I already knew everything there was to know about my car-buddies.

Fig. 17: An untypically rainy start of our long drive eastwards (Photo S. Bertschi)



And the day after, I could get to know three new geographers.

We were driving along the Great Eastern Highway through the region of the Wheatbelt, one of Western Australia's nine regions, that got its name from wheat cultivation. During the over four-hour drive we only had short breaks for having an awful coffee at McDonalds in a very small town (I even can't remember the name) and of course when nature was calling. In this manner we managed to have lunch half way between Freo and Kalgoorlie in the middle of nowhere.

Fig. 18: Preparing lunch (Photo J. Sturm)

This day started our new tradition of having wraps for lunch. Still with great enthusiasm everyone helped to prepare lunch and we had a relaxing break at the side of the Great Eastern Highway.

Fig. 19: : The Great Western Woodlands through an already very dirty windscreen (Photo F. Moergeli)

The second part of the drive was shorter and lead us through the Great Western Woodlands, the largest remaining area of intact Mediterranean-climate woodland on Earth. After another three hours we came across Coolgardie, a small town with approximately 1000 inhabitants, that had been, like Kalgoorlie, a gold mining city. These days have long gone, and it is now famous as a ghost mining city.

Finally, after more than a 600 km drive we reached Kalgoorlie, the city at the end of the Great Eastern Highway. The town was founded in 1893 during the Yilgarn-Goldfields gold rush close to the gold mines. With over 30'000 inhabitants, it is the fifth-largest urban town in Western Australia. We were camping at the Discovery Park campground in Boulder where some of us started to arrange the tents while some went shopping for groceries. The weather had turned out rather nice and the temperature was bearable, so we had a nice BBQ before trying to go to bed. It so happened that the one and only lantern located in the centre of our campsite did not turn off the light. While some of us had no problem sleeping under this radiant light source, some were moving their tent in the middle of the night.

Fig. 20: Meeting the RSL in the ghost town Coolgardie (RSL stands for The Returned Services League, Australia) (Photo J. Sturm)

Fig. 21: Group camp at Discovery Park (Photo F. Moergeli)

The Wheatbelt

Franziska Moergeli

This region received its name from the European settlers who cultivated wheat on this very fertile land. The Wheatbelt covers 154’862 square kilometres in the south west of Western Australia and is inhabited by approximately 75’000 residents (2013). It consists of five sub-regions: Avon, Central Coast, Central East, Central Midlands and Wheatbelt South. Each sub-region is serviced by a sub-regional centre (Northam, Jurien Bay, Merredin, Moora and Narrogin) and has unique economic and population drivers.

Agriculture and mining are the region’s main revenue earners. The Wheatbelt’s agricultural industry is the state’s main producer of cereal crops and contributes to other products such as canola, olives, vegetables, wine grapes, honey, citrus fruits and livestock. While agriculture remains the dominant industry, the economy is also supported by mining, commerce, retail, manufacturing, fishing and tourism [1].

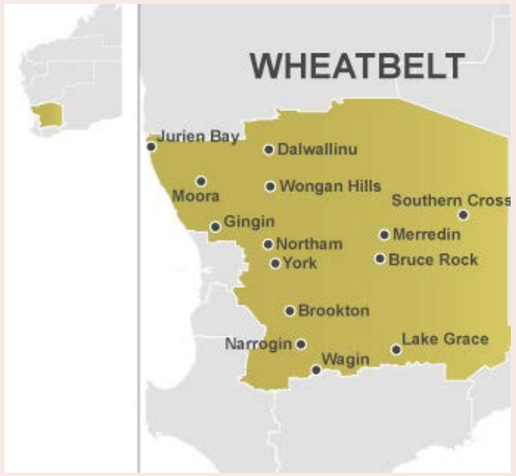


Fig. 22: Extent of the Wheatbelt [1]

The Western Woodlands

The Great Western Woodlands are an internationally significant area of great biological richness. They are the largest remaining area of intact Mediterranean-climate woodland on Earth. Covering almost 16 million hectares—about the same size as England— this continuous band of native vegetation stretches from the edge of the Western Australian Wheatbelt to Kalgoorlie-Boulder in the north, to the inland deserts in the north-east and the Nullarbor Plain in the east.

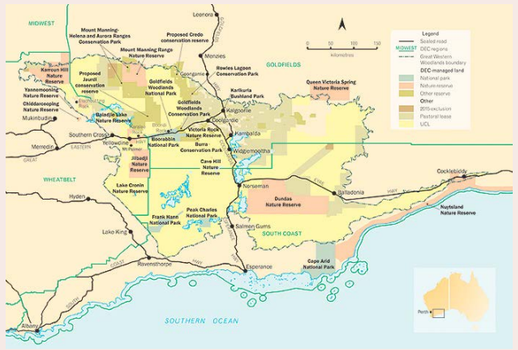


Fig. 23: The Great Western Woodlands [2]

This region represents the largest and most intact eucalypt woodland remaining in southern Australia and one of the best examples of its type in the world. It is home to an impressive 3’000 flowering plant species, 20% of Australia’s known flora, as well as a diverse range of animals (numerous species of mammals, reptiles, frogs and birds) dependent on its varied habitats. The area is well known for its diversity of eucalypts with some 160 species recorded. Aboriginal people have lived here for at least 22’000 years and maintain their strong connections to the land. In addition to its extraordinary natural and cultural values, this is also a highly productive landscape. The Great Western Woodlands are located in one of the richest mineral provinces in Australia and contain 334 operating mines as well as an active exploration and prospecting sector. Pastoralism, timber harvesting and tourism are also important in the area. The people who live here have built strong communities based on natural resources.

This ancient landscape of broad, flat valleys and ridges experiences hot dry summers and frosty winters. Elevations range from 140 metres in the south and east to 500 metres west of Kalgoorlie. There is almost no permanent water and there is almost no rainfall (250-350 mm). Surface water flows into salt lakes from which it evaporates rather than draining to the sea. The low, variable rainfall and lack of potable groundwater made the Great Western Woodlands less attractive for agriculture and livestock grazing than the lands further south and west. The Great Western Woodlands span two climatic and botanical zones: the wetter south-west and the arid interzone. These conditions support more than 3’000 flowering plant species representing some 20% of Australia’s known flora, as well as numerous species of mammals, reptiles, frogs and birds.

The Great Western Woodlands are also important for the existing and potential economic development of the region, with significant mining and exploration activity, active pastoral leases and timber resources, and are increasingly popular for recreation and tourism.

The management strategy for the Great Western Woodlands provides a framework to manage the range of different uses of the woodlands to ensure the long-term protection of their natural and cultural values. The strategy was prepared with the help of a Stakeholder Reference Group that included community-based groups along with industry organisations and local government authorities [2, 3, 4].

Malleefowl

During our visit to Kalgoorlie’s Department of Parks and Wildlife (DPAW) we have been told about a very threatened and endangered species called Malleefowl (Thermometerhuhn). It has the size of a chicken and is native to the regions around Kalgoorlie. The species is notable for its large nesting mounds constructed by the males and a lack of parental care after the chicks hatch. We were informed that we would most certainly not see any of these shy birds because almost no one ever does. We learnt that their mounds are very difficult to be located and are therefore detected by high resolution aerial photography. This effective technique helps to protect the local bird.

Fig. 24: Malleefowl on its mound [5]

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Fig. 25: Emus (Dromaius novaehollandiae) (Photo A. Hueni)

Fig. 26: Dingo (Canis lupus dingo) (Photo J. Sturm)

Fig. 27: Western grey kangaroo (Macropus fuliginosus) (Photo J. Sturm)

Australian animals

Andy Hueni

The fauna of Australia presents certainly a major attraction to any visitor. Most tourists look forward to encountering the big boned Grey Kangaroo, the cuddly wallabies or the sleepy koalas, while being mortally afraid of getting too closely acquainted with the manifold of dangerous animals including sharks, snakes, spiders and jellyfish.

The connaiseurs among the ornithologists will value the large diversity of birds to be spotted in Australia with many species being native to the continent with a total of 867 species having been recorded so far [1].

Australia is of course famous for its large number of marsupials. The 334 exant species occuring in the Australian continent comprise nearly 70% of all marsupial species worldwide [2]. Spotting these animals is however tricky, as many have developed a nocturnal activity pattern. Travelling between dusk and dawn in rural and outback areas cannot be recommended, as these are the times when many animals will be active and the danger of hitting one is rather high.

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[1] birdlife.org.au
[2] en.wikipedia.org/wiki/Marsupial

Fig. 28: Perentie (Varanus giganteus) (Photo A. Hueni)

Fig. 29: Gibber Earless Dragon (Tympanocryptis intima) (Photo D. Fawcett)

Fig. 30: Presumably a Brown Snake (Pseudonaja textilis) (Photo S. Roth)

Fig. 31: Singing Honeyeater (Gavicalis virescens) (Photo A. Hueni)

Fig. 32: Galahs (Eolophus roseicapilla) (Photo D. Fawcett)

Fig. 33: Mulga parrot (Psephotus varius) (Photo J. Sturm)

Fig. 34: The Super Pit mine near the city of Kalgoorlie is Australia's largest open cut gold mine and one of the largest open-pit mines in the world. The pit is roughly 3.5 kilometres long, 1.5 kilometres wide and 570 metres deep. The Super Pit was created in 1989 by Kalgoorlie Consolidated Gold Mines Pty Ltd (KCGM). The metropolitan area of Kalgoorlie extends almost to the mine's pit. Extracting even small quantities of gold requires huge quantities of ore. Waste dumps and gray-white tailings ponds with chemicals left over after the gold is extracted sprawl over the arid landscape. This true-colour image was captured on 15 February 2010 by the Advanced Land Imager (ALI) on NASA's Earth-Observing-1 (EO-1) satellite. (Source: NASA Earth Observatory, earthobservatory.nasa.gov/IOTD/view.php?id=42763).

Kalgoorlie: Visiting the Super Pit Goldmine and Kalgoorlie's Department of Parks and Wildlife (DPAW)

Fig. 35: Our Super Pit tour bus (Photo J. Sturm)

Day 4, 20 January 2016

Sandra Roth

Intending to write a report with lots of little details this text once had been written exemplarily on my tablet during another long drive through Australia's vast wilderness. But Australia wouldn't be Australia if it wasn't known for all the dangerous things that can happen to you while traveling around. To this day it couldn't be determined what finally caused the death of my tablet and with it my detailed daily report. But fact is that both unfortunately didn't survive the extreme conditions and adventures we faced in Down Under. Therefore this new report you are reading right now contains fewer details but in return has more of these vague longtime memories where some things seem to be much funnier than they appeared to be the moment you experienced them.

Well, the morning as usual started too early for many of us… Nevertheless most were awake anyway long before all the different alarm clocks in each tent went off as a whole covey of Australian parrots had decided to fly over the campsite again and again screeching as if all of them were about to be murdered.

After an early breakfast with many sleepy eyes and marred ears we headed to Kalgoorlie's town center with our car caravan.

Fig. 36: A squeezed car at the entry to the Super Pit – just to make sure that the safety rules are obeyed… (Photo J. Sturm)

Naturally our expectations for the tour were rather high as one does not visit the world's fourth largest open gold mine every day.

It was in the middle of the center where we were intended to register for the Super Pit Goldmine tour. After our drivers finally found four empty parking lots we all entered the tour's small office located at the corner. There everyone went through the name check, had a "glasses-control" (where the sun glasses where examined on whether they really protect the eyes or if some special protection glasses were required instead) and was armed with one of these super sexy over-size reflective vests. Once the bureaucracy was done we were allowed to leave the office to wait outside until the bus would depart. Naturally all the girls took advantage of this little free time to look for the free of charge toilet the tour guide indicated. It wasn't too hard to find and the cleaning lady there for sure made the fortune of her life because the use of course wasn't for free…

Fig. 37: One of the massive trucks carrying 218 tons of mined rock (Photo S. Roth)

Fig. 38: Super sexy group photo in front of the Super Pit Goldmine (Photo Tour guide with M. Kneubühler's camera)

Naturally our expectations for the tour were rather high as one does not visit the world's fourth largest open gold mine every day. And luckily soon the doors of the Super Pit bus opened and off we went. As not only Australia is dangerous, but also the Super Pit with all its enormous vehicles, some strict rules had to be obeyed, which were shown to us in a video while driving towards the pit. To clarify their message, a squeezed car is exhibited at the entry of the Super Pit. Only a few metres after we passed the entry gate it not only got clear that they are very stern about the safety requirements but are even more proud of the gigantism of the whole pit and all that is related to it. Proudly our guide declared that each of their huge trucks, which are used to transport the mined rocks from the bottom of the pit to ground level, burns several hundred liters of fuel every hour.

Also the tires of all the vehicles driving around the pit (even our tour bus) are far beyond the normal and have to be especially made of extra strong rubber to manage the gravel roads winding through the whole pit. Even the traffic system itself is unique, as all these huge lorries carrying the rocks have the right of way all the time. Furthermore they

Fig. 39: Wonderful rock formations at the Super Pit Goldmine (Photo J. Sturm)

Fig. 40: Trucks hauling ore out of the pit (Photo A. Hueni)

Fig. 41: Panorama of the Super Pit (Photo J. Sturm)

have built extra roads at the crossings for all the "small" vehicles to prevent them from being run over by one of these hulks as the drivers can hardly see them. While heading towards the first save lookout we already crossed with two of these before mentioned extreme machines. Each of them has a display on the outside, indicating how many tons of rocks it is carrying at the moment. Most of them hauled about 200 tons of rock. Our tour guide also explained to us that each driver was instructed of where to deliver the particular cartload. After each blast engineers evaluate the quality of the rocks and decide which parts might contain gold and which don't and according to this they have to be processed differently at different places in this huge gold mine. Although the mining business still is dominated by men we were proudly told that the Kalgoorlie Consolidated Gold Mines Pty Ltd (KCGM) employs 40% women.

From our first lookout we had a great view over the length of the whole pit. Although this whole business must be questioned in many points, one still has to admit that this huge man-made hole has something beautiful about it. Especially the rock formations that were visible in stunningly colored strata were photographed over and over again by all of us. But as with every tour, the next look-out was waiting already and thus all of us got back into the bus and we continued our way through the pit.

After another stop we finally went "into" the pit itself. I guess a lot of us had hoped to really get down into the pit and were a bit astonished as our guide and driver already pulled the bus over into another stopping place after we went down a small slope. As we now were "in the pit itself" as our guide always emphasized it got even more dangerous than it had been before. Of course our shiny orange vests and the highly protective glasses weren't prevention enough down here and a stylish white helmet therefore had to be added to complete the outfit, which was documented in several pictures.

As we now were "in the pit itself" ... it got even more dangerous than it has been before.

For the last time we got back on the bus, which took us back to the ground level again. The attention of some of us slowly started to deteriorate due to the massive Australian heat impact (yes indeed the sun funnily enough was shining on that day) and all the information our brains weren't able to process after a long semester. Undeterred by this, our driver kept talking on and on. Before making our way back to Kalgoorlie itself we were taken to the huge mills where the rocks are getting crushed, milled and the gold (dust) is extracted. As everything else in the Super Pit, they were simply humongous.

Fig. 42: Mill balls of a nominal 125 mm diameter, used in mills to break the rocks down to gravel size (Photo A. Hueni)

Fig. 43: Members of the excursion are awed by the size of the Super Pit (Photo S. Bertschi)

Fig. 44: Part of the milling facility (Photo J. Sturm)

Fig. 45: A rock crusher to break down family car sized boulders to a more managable size (Photo S. Bertschi)

Gold rush in Western Australia and the Super Pit in Kalgoorlie

Fabienne Maag

History of Kalgoorlie

In January 1893, the three gold prospectors Patrick Hannan, Tom Flanagan and Dan O'Shea were travelling to Mount Youle west of Perth. During a rest, they found several signs of possible gold deposits, thus they decided to stay in this area and try to find some gold. On the 17 June of the same year, Patrick Hannan filed a reward claim, which induced many other men to come to this particular area and to dig for gold. In this manner, Kalgoorlie, originally called Hannan's, was born. Directly next to the mines, today's city of Boulder was founded at around the same time as a camp for the miners [1].

Fig. 46: Golden Pipeline between Perth and Kalgoorlie (Photo J. Sturm)

One of the biggest problems in those days was Kalgoorlie's location in the middle of the Australian Outback. Naturally, water was always a scarce good. But in 1898, Charles O'Connor created a transport system using pipes made of steel and involving eight pump stations. Consequently, the so-called Golden Pipeline transported water from the mountains around Perth to the Mount Charlotte-Reservoir since its completion in 1903. During the years of the 1890's the Golden Mile boomed and the population exceeded in that time 200'000, whereas most of them were prospectors. The area was then known as a wild-west like territory caused by rapid increase of population and land claims [1].

Already in 1903, 49 mines, 100 headframes and 300 kilometres of underground working shafts existed in the area of the Golden Mile. In 1980, the Western Australian businessman Alain Bond started to buy many individual leases and created a big company to reduce the mining costs by mining in one huge pit. In 1989, the whole mining area of Kalgoorlie was combined and the Kalgoorlie Consolidated Gold Mines Pty Ltd (KCGM) was created. The existing small pits were merged into the Fimiston Open Pit or so-called Super Pit [2], [3]. Today, this pit is 3.5 kilometres long, 1.5 kilometres wide and deeper than 600 meters, set to approach the 700 metre mark very soon. Thus, the Super Pit has nearly the same dimensions as the Uluru. Around 800'000 ounces of gold are gained from the pit every year [4]. Since 2002, Barrick Gold Corporation and Newmont Mining Corporation are equal owners of the Golden Mile lease and the company KCGM. In 2014, KCGM poured its millionth ounce of gold and the KCGM contributes to Australia's position as second largest gold producer in the world, directly after China. The estimated end of the mining activities in the Super Pit is planned for 2019 when a depth of 700 meters will be reached [2].

Fig. 47: The famous Exchange Hotel in Kalgoorlie was built in 1900 (Photo M. Kneubühler)

Super Pit mining today

The open mine operates 24 hours a day, 7 days a week, and from a visitor centre constructed on one side of the pit, tourists can also see the actions during night. The mine blasts daily at 1pm, except in case wind would carry dust over the town. Each of the massive trucks can carry around 225 tonnes of rock. Each employee must live in Kalgoorlie, but neither man nor woman is officially referenced as long as they are able to drive and serve heavy machinery.

The Golden Mile ore is of two main types: weathered oxide ore from near the surface which is free-milling with the gold easy to extract, and sulphide ore in deeper ore bodies where the majority of the gold is locked as inclusions in tellurides and pyrites and is difficult to extract. In the sulphide or telluride ore, the gold is chemically combined with tellurium, an element related to sulphur, and the complex extraction process involves several stages [3]. The process of extracting gold from sulphide ore begins when the trucks delivering the ore from the blast site to the run of the mine pad at the Fimiston Plant. There, an employee reduces the size of each piece of rock to the size of a fist. The ore is then grounded into particles with a diameter less than one-fifth of one millimetre in large rotating Semi Autogenous Grinding and Ball Mills, which look like huge steel drums. Water is added to create a mud-like slurry, which is pumped into large tanks called flotation cells. Then, air is added to the bottom of the agitating flotation cells and the resulting froth, which accumulates at the top of the mixture, contains a combination of free gold, gold-bearing pyrite and telluride particles. This mixture in the froth is known as sulphide concentrate [3]. The sulphide concentrate is collected and dried by filtering and afterwards either treated in the Ultra Fine Grinding Mill (UFG) at Fimiston, processing 10 tonnes per hour (tph), or trucked to the Gidji Processing Plant, where it is treated either in the 10tph UFG Mill or the 30tph UFG Mill. To extract the gold, a 30% cyanide solution, lime, oxygen and lead nitrate are added to the sulphide concentrate in a large mechanically agitated tank of the Carbon In Pulp (CIP). The mixture is moved into adsorption tanks containing granules of activated carbon to adsorb the gold, which has leached into solution [3]. Afterwards, the carbon is removed from the circuit and when the process is completed almost all of the gold is removed from the mixture [3].

Of course, the gold has to be removed from the carbon, which is done using the elution process. Therefore, the carbon containing the gold is sealed in a metal pressure vessel and washed first with hydrochloric acid, afterwards sodium cyanide, then a caustic soda solution and finally hot water under pressure [3]. Using two electrodes of steel, the gold can then be removed from the solution by passing an electric current through the solution. Because of its electrochemical characteristics, the gold covers one of the electrodes. This gold can eventually be used to form gold bars, containing between 60% and 80% of pure gold, the rest is mainly silver. The bars are transported by aircraft from Kalgoorlie to Perth under strict security measures.In the Perth Mint these gold bars are refined to 99.9% pure gold [3].

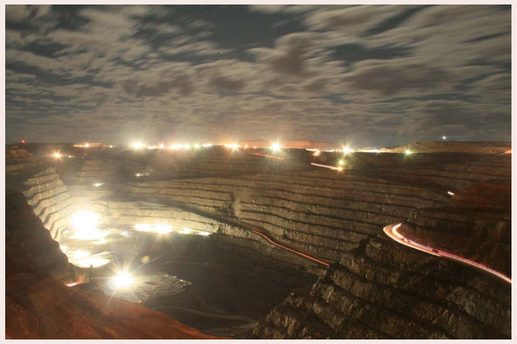

Fig. 48: Super Pit mining during night (Photo A. Hueni)

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Back in town it was time to have some lunch and recharge our brain's batteries as we all knew that its absorbing power would be strained once more in the afternoon. Luckily our two "chiefs" had looked for a good place to enjoy lunch in advance wherefore we ended up at a beautiful little pond with lots of shady trees where we once more had wraps, dips and couscous. As the rather short night combined with an intense morning still heavily weighed on some of us a coffee stop was up next on our program before we headed to Kalgoorlie's Department of Parks and Wildlife (DPAW).

There we were warmly welcomed by Ian and the rest of the staff. The darkened room in fact wasn't very helpful to fight the well-known fatigue which regularly hits students in the afternoon, but the presentation luckily was very interesting and Ian was very motivated to inform us about their job.

… that the Mining Law in Western Australia stands above all other laws (nature conservation etc.) as mining is such an important economic power there.

The two things that personally impressed me most was on the one hand the vastness of their area of operation for which they had to take care and on the other hand, that the Mining Law in Western Australia stands above all other laws (nature conservation etc.), as mining is such an important economic power there.

After Ian's general input about the department's work, we had another presentation about a special application of remote sensing, which they recently implemented and really facilitates their lives. More precisely, they try to find the mounds of malleefowls by using aerial photography and thermal remote sensing as these heaps not only have a very distinctive shape but due to their size and elevation also show a different temperature than their surroundings. This method proves to be much more effective and by far less time consuming than having volunteers walking through the bushes and scrubs, hoping to "accidentally" find such a heap.

After a very long Q&A session with lots of interesting questions from our side and some networking to keep in contact, we left the department with lots of new background knowledge and really worn out brains.

Fig. 49: Having lunch as usual – sitting in a circle eating wraps (Photo M. Kneubühler)

Fig. 50: Tired from a long day we are waiting to get back to the campground (Photo M. Kneubühler)

Fig. 51: A miner's nightlife attractions being advertised (Photo M. Kneubühler)

Fig. 52: Kalgoorlie City Centre (Photo S. Bertschi)

While I had the luck of getting a personal driver, who took me to one of Kalgoorlie's outdoor shops to buy myself a sleeping bag to survive Australia's bitter cold summer nights, the rest of the group explored Kalgoorlie.

Although all of us were pretty tired after this long day, the rumors about Kalgoorlie's infamous night life, developed to meet a lonely miner's needs, were too juicy to be missed out.

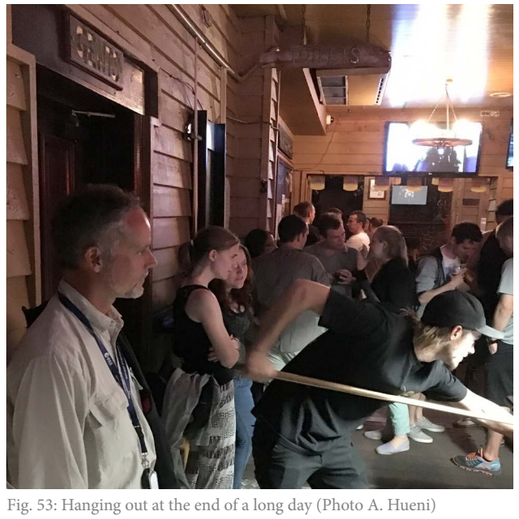

Fig. 53: Hanging out at the end of a long day (Photo A. Hueni)

Therefore we headed out to Kalgoorlie once more after another delicious BBQ for dinner. On the way we stopped at a huge parking lot where one could have a look at the Super Pit by night. As this mine is operated 24 hours a day and 365 days a year everything is light up at night and the trucks are driving just as they did when we were at the mine with the tour bus. After a nighttime photo session we headed towards the town center.

It didn't take us long to find a place that looked decent enough to visit during an University excursion, but still promised to give an insight into Kalgoorlie's night life. Honestly, it turned out to be a rather normal bar with two or three scarcely dressed barmaids. While many of the women of our group soon concluded that the ladies behind the counter weren't that special, the men wisely didn't comment the scene. Besides the fact that large groups tend to stand out we also might have made an impression of being slightly out of place. It didn't take long before some very brave regulars approached us to find out where we were from and what we were up to. While some of us played billiard, others were just sipping on their drink and had a chat. Maybe some of us had hoped for a bit more action or let's say show, but it was still a nice conclusion of a very long and intense day and our two "Excursion managers" once more proved that they really are two easy-going guys who enjoyed the excursion just as much as we did.

Remote sensing and GIS institutions

Dominic Fawcett

Australia boasts a great number of Remote Sensing and GIS institutions, most of which operate on a national level. The Australian government is investing in developing and promoting the RS & GISciences in various fields.

On our trip we visited two such institutions: CSIRO and the Curtin University Remote Sensing and Satellite Research Group (RSSRG). The interested reader may refer to Daily Report 2, detailing our experiences at these institutions.

This Theme-Box seeks to give a brief overview of these and further RS and GIS Institutions in Australia along with descriptions of their main activities.

Geoscience Australia (GA) is an Australian Government entity, seeking to support the government, industry and stakeholders by providing geoscience information and services [1]. For example, they are responsible for the distribution and management of satellite imagery to aid decision making.

One of their main functions is managing overlapping interests of the many other geoscience related government agencies.

GA Projects include: Prospection of fuel in the Bight Basin; Gawler Mineral Promotion Project which led to discoveries of 6.3 million tons of copper in the Gawler Craton; Development of a groundwater flow model to understand and preserve springs in the Great Artesian Basin; Release of the first national census of land cover information from satellite imagery spanning 11 years.

The Australian Geospatial-Intelligence Organisation (AGO) [2], which is part of the Department of Defence: Intelligence and Security, uses remotely sensed imagery as well as geospatial analysis for military purposes, but also to ensure national security in cases of natural disasters.

AGO Services include: Provide military operations with products such as route studies, line-of-sight threat analysis and maps. Also provide information in cases of emergency, like rapid mapping, the 'Palanterra' real-time spatial information sharing capability (previously used for observing and reacting to floods, earthquakes and tsunamis) and bushfire monitoring [3] (in collaboration with CSIRO which provides the SENTINEL software).

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) is Australia's national science agency. CSIRO's origins date back as far as 1916 when there was a first push towards a 'national laboratory'. In the early years the primary focus lay mainly on farming and mining. During World War II its research aided the military, for example advances in radar technology. CSIRO has since ceased working for the military and greatly expanded its fields of interest. Nowadays CSIRO also comprises material and environmental sciences.

CSIRO Projects: Most famous for being a key player in the development of Wifi technology as it is used today. During our visit to CSIRO, we got an overview of current remote sensing projects being carried out, most of them focused on remote sensing of minerals. These include: Rapid mineral characterisation and logging drill cores using spectrometers (HyLogger), vicarious calibration of satellite sensors and the search for ideal calibration sites within Australia and finally the creation of mineral maps from ASTER data.

The Surveying & Spatial Sciences Institute (SSSI) [4] represents the interests of spatial professionals (individuals educated in spatially oriented sciences). It contains multiple subdivisions for different fields such as 'Remote Sensing and Photogrammetry' and 'Spatial Information and Cartography'. The institute offers certification to spatial professionals, which is recognized internationally, as well as career support and other services which are helpful for orientation on the job market. The SSSI also organizes a broad range of workshops, seminars and conferences on regional and national Level.

A similar role as the SSSI is fulfilled by the Mapping Sciences Institute Australia (MSIA) [5], which is an association of professionals in map-making and geospatial sciences. Initially (1952) it was limited to cartographers but nowadays the Institute is welcoming a broader range of spatial professionals. Today the MSIAs role is to promote mapping sciences in the education sector and communities. Probably due to their similarity with the Cartography division of the SSSI, the two Institutes have signed an official contract promising mutual support.

The Australian Urban Research Infrastructure Network (AURIN) [6] provides an online portal created through an initiative of the Australian Government and led by the University of Melbourne. It contains a collection of open source GIS tools, which allow spatial analysis, planning and visualization. The network's goal is to further the understanding of Australia's urban regions and to contribute to their sustainability.

The Curtin University Remote Sensing and Satellite Research Group (RSSRG) [7] is part of the Faculty of Science and Engineering. They are internationally oriented and collaborate on a number of projects with the likes of NASA. The recently appointed head of the group, Prof. David Antoine, brings with him a highly developed skillset in marine optics and ocean remote sensing. The group's research focus is therefore mainly on Satellite Oceanography, but it is also strong in Atmospheric Science.

There are many more notable institutions, which aren't further elaborated here. Most big Universities in Australia possess a Geoscience department. Some have larger research groups in Remote Sensing like Curtin University mentioned above, while others are more focused on GIS like the University of Melbourne. In the commercial sector we find companies like ESRI Australia and the Spatial Scientific group of companies [8] including Remote Sensing Australia and Aero Scientific, who have clients ranging from the state and academic institutions to mining companies and consultancy firms.

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Kalgoorlie - Lake Lefroy - Fraser Range

Day 5, 21 January 2016

Dominic Fawcett

Today would take us southwards from Kalgoorlie on a comparatively short drive of only 300 km until we reached Fraser Range, our next stop for the night. On the way lies Lake Lefroy, a great salt lake whose brilliant white surface can be used for satellite calibration.

Back at CSIRO we heard about projects involving the salt lake, including a remote controlled robot capable of driving around on it and autonomously taking spectral measurements. As we learned, these reference measurements are by no means constant. The variable state of the atmosphere determines the incoming radiation and the humidity of the air influences the salt crystals, leading to different reflectances (See theme-box on Vicarious Calibration for more details).

While the makeshift spectrometer Andy had brought along didn't promise any accurate measurements, we were still eager to get a closer look.

Fig. 54: Lake Lefroy (Photo S. Bertschi)

We got a first stunning view of Lake Lefroy from the Red Hill Lookout just outside of Kambalda. The Lookout was aptly named as the rocks here showed those intense red and orange tones which the Australian Outback is so famous for. Despite the dry and rocky ground the hill was still dotted with hardy Eucalypts. Lake Lefroy spanned the horizon as a vast expanse of white. However, due to recent rainfall there were still parts of it covered by shallow water, something to be considered when selecting regions for calibration.

Lake Lefroy spanned the horizon as a vast expanse of white.

After a brief walk around the hill we took shelter from the midday sun as Andy and Mathias gave a talk on vicarious calibration (See theme-box).

Fig. 55: On a short hike from Red Hill Lookout (Photo J. Sturm)

Having seen the lake from a distance, the plan was now to get a bit closer to either walk on the salt crust or drive on one of the roads crossing it. This proved rather more difficult than we had anticipated.

Fig. 56: Outdoor lectures in remote sensing (Photo M. Kneubühler)

Vicarious calibration

Dominic Fawcett

Radiometric calibration is necessary for all imaging sensors in order to guarantee the accuracy of the instruments and the comparability of their measurements over time [1, 2]. There are a range of different calibration methods and usually as many as possible are used as they complement each other. For airborne sensors such as APEX, highly accurate calibrations can be performed in laboratory conditions of so-called Calibration Home Bases [3]. This option doesn't exist post-launch for sensors mounted on satellites. One has to rely on on-board calibration using lamps and solar radiation, on cross-calibration using other satellite instruments or on vicarious calibration. Vicarious calibration describes the method of calibrating satellite sensors using reference targets and measurements on the ground [4]. It is needed in addition to on-board calibration because it is independent of any degradation of the satellite's calibration facility. The two main techniques of vicarious calibration are the radiance and the reflectance based approach where in-situ measured radiance or calculated reflectance are compared with the sensor measurements. Both of these require suitable reference surfaces on the ground, meeting a list of criteria:

- The site reflectance should be greater than 0.3 to avoid a large relative impact of atmospheric scattering on measured radiance.
- A site elevation greater than 1km is preferred to reduce aerosol impact.
- The site should be spatially uniform over a large area, reducing adjacency effects and maximizing scale-independence of the measurement.
- The site should remain unchanged over time and mostly cloud-free.
- Site reflectance should be nearly Lambertian to reduce viewing-angle effects.
- The site should be spectrally uniform for smaller influences of band-mismatch between the sensor used in-situ and the sensor to be calibrated
- The site should be easily accessible for repeated calibration.

Criterion number 4 heavily favours arid calibration sites and most calibration activities focus on desert regions, for example the calibration of MERIS at the Railroad Valley Playa in Nevada [5, 6]. If we were to evaluate Lake Lefroy based on these criteria, it would be safe to say that it fulfils most of the requirements. Its largest shortfalls are its elevation of only 300 m and its distance from CSIRO and other relevant parties. Also, considering the reflectance spectrum (Fig. 57) the reflectance could be flatter spectrally. Although we witnessed some variability in the weather and patches of cloud, conditions seem relatively stable when looking at the AERONET measured values of atmospheric water vapour in 2016 so far (Fig. 58).

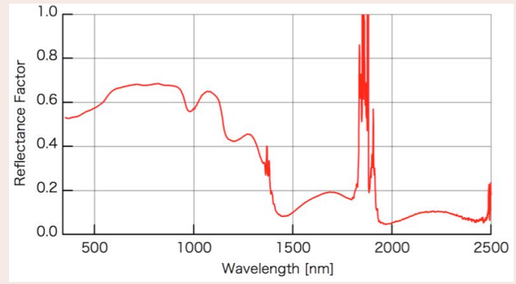

Fig. 57: Lake Lefroy reflectance spectrum [7]

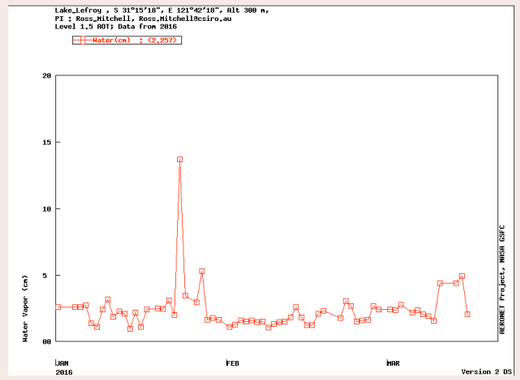

Fig. 58: AERONET water vapour values for Lake Lefroy [1]

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Fig. 61: Breathtaking view over Lake Lefroy from the nearby Red Hill lookout at Kambalda (Photo S. Bertschi)

Hydrogeology of salt lakes

Dominic Fawcett

Lake Lefroy

In arid and semi-arid regions, groundwater is often saline as opposed to fresh water. In Australia more than 80% of lakes and wetland areas are saline and most of these can be found in Western and South Australia as these are also the driest states. Here we will focus on the two salt lakes we came across on our trip.

The bed of Lake Lefroy lies just 5 cm above the boundary of the groundwater table. About 64% of the lake is covered in a halite crust, up to 10 cm thick and there are small salt volcanoes to be found where sulphuric gases escape from the sediments below. Most of the halite crust dissolves during the rainfall maxima of winter and precipitates again, as evaporation exceeds rainfall by a factor of 10. Water depth ranges from 20 cm after extensive flooding to a maximum of 2 m after extreme events. The lake is not devoid of life as when there is surface water, ephemeral microbial mats can be found.

Around 25% of the year the lake is completely dried out and it is assumed that this cycle has been ongoing since the beginning of the Pliocene (5.333 Ma BP), recorded in a switch from clastic sedimentation to evaporites [2].

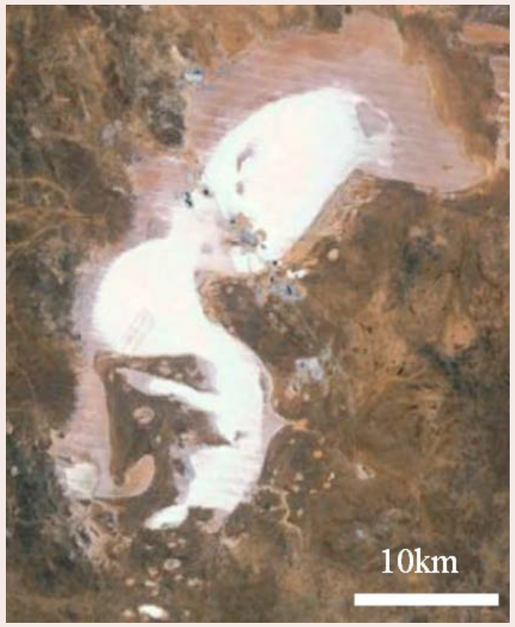

Fig. 60: Lake Lefroy [1]

Lake Eyre

The largest ephemeral lake in the world, Lake Eyre was long considered to be permanently dry until the first filling in 1949. The fillings remained few and far between but recently a link has been established between lake fillings and the El Niño-southern oscillation.

The lake is surrounded by a very large drainage system, which explains why the water volumes flowing into the lake can be huge after heavy rainfalls. It is also the reason that only a small increase in precipitation could have a large effect on lake filling.

The Lake Eyre basin lies above the Great Artesian Basin. There is an extremely slow flow of water from the mountainous regions, through the aquifers until they reach the terminal base level of the lake (three million years travel time). The lake is also surrounded by fault-controlled mound springs whose discharge flows into it.

Salt crusts are up to 46 cm thick and only dissolve after major inflows. The origin of the salt is not completely solved. Theories of processes depositing salt include marine aerosol transport as well as rock weathering and groundwater discharge from the aquifers [3].

The predicted increase of summer rainfall by 50% and decrease of winter rainfall by 20% by 2030 due to climate change would mean significantly more water in the tributaries of the lake. However, whether this also means greater and more frequent infilling is debatable as transmission losses increase due to higher temperature and thus also more evaporation [4].

Salt lake ecosystems in Australia are threatened not only by climate change but changes to the landscape with a multitude of causes. Primary among these are secondary salinisation of the landscape, mining and groundwater use. The significance of salt lakes for specially adapted flora and fauna is not well researched and more than often neglected.

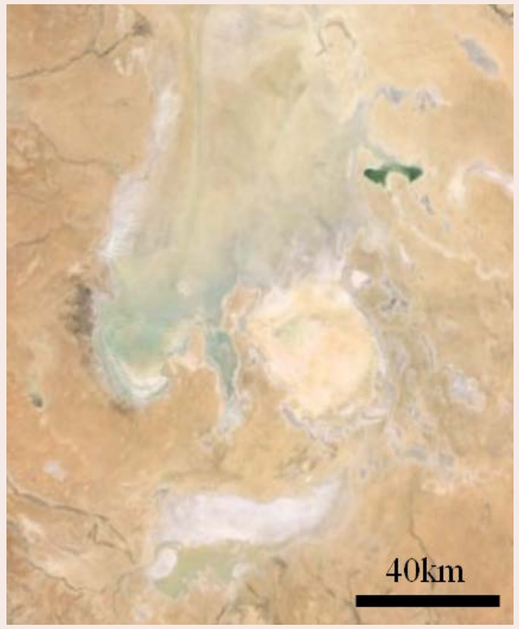

Fig. 62: Lake Eyre [1]

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Fig. 63: Trying fo find access to the southern part of Lake Lefroy (Photo S. Bertschi)

We reached the road leading across the lake where we were told that it was out of bounds except for mining related traffic to the Revenge gold mine. Turning around was the only option, but that didn't mean we accepted defeat! The road southwards didn't lead directly along the lake and it was obscured from view. We would need to turn off soon to have a chance of reaching the lake. An opportunity came in the form of a dirt track and we decided to take our chances.

Like the lizard's, our fortunes were soon about to change.

On the dirt track we stopped for an interesting lizard. Unfortunately, one of our cars had already run over it and it wasn't a pretty sight. While the other drivers tried to shift the blame, Andy grabbed a shovel and put it out of its misery. Like the lizard's, our fortunes were soon about to change.

While the day had been hot and dry so far it seemed that the previous rainfall had not yet drained into the clayey ground, turning stretches of the dirt track into a very muddy affair.

With our goal almost in sight we pushed on nevertheless while the tracks left in the mud by Andy in the front car deepened until he came to a halt, wheels spinning. Luckily the other cars were still on safe ground and Christoph was able give Andy a hand by towing him out of this sticky situation with his Nissan. Although we ultimately failed to reach Lake Lefroy we all felt that we'd still had quite the adventure and it was time to move on in the direction of Fraser Range.

...until in the mud, he came to a halt, wheels spinning!

Fig. 64: Andy is cheerfully assessing the situation after getting stuck in slimy mud (Photo D. Fawcett)

Fig. 65: A harmless looking bit of track has defeated one of our cars (Photo S. Bertschi)

At Norseman we stopped to shop for the evening meal and restock our supply of wraps. Meanwhile the Western Australian weather proved its variability once more and we had to take care not to get soaked in torrential rain whilst stowing the groceries in the cars.

Fig. 66: Petting of the campsite's python (Photo D. Fawcett)

Fig. 67: Evening light on the Fraser Range farm land (Photo F. Maag)

Fig. 68: Double rainbow over Fraser Range camp (Photo J. Sturm)

Fraser Range proved to be the most attractive campsite so far. There weren't many campers about and it was quite close to nature, surrounded by green hills and Australian wildlife. Flocks of Cockatoos sat up in the trees and just beyond the fence we spotted a group of emus, a first for many of us. We also had a very close encounter with a snake! It might have been the local ranger's mostly harmless pet python but it still counts... The mood was briefly dampened by another bout of rain but the rainbows appearing afterwards more than made up for it.

Once the weather improved we were feeling restless and soon took off into the surrounding hills because we had heard there were usually many Kangaroos about and we had yet to see a live one on our trip. The evening turned out to be truly beautiful and the landscape was illuminated in orange light. We spotted the first Kangaroos in the distance, still only dark shapes even when peering through binoculars. But soon enough there were more and more sightings, some of us managing to get as close as a few meters when approaching quietly. Satisfied we returned to camp and rounded off the evening with a nice meal, a few beers and some gripping tales of past adventures.

Fraser Range - Eucla

Day 6, 22 January 2016

Tobias Klee

It was 6.30 am, and the ones who weren't already awake due to bird screams, or to walk in the dawn and spot some kangaroos, got up as well. Unfortunately, the slight rain in the night and the morning kept the tents wet for the drive. At 8 am our caravan started the longest drive of the excursion: 620 kilometres from the woodlands of Western Australia towards the Nullarbor Plain including the longest straight road of Australia. From outside, our convoy must have seemed a mix of tourists, important politicians and animal protection charity advocates.

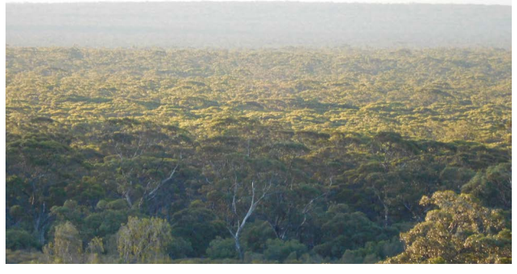

Fig. 69: Still in the Woodlands of WA (Photo T. Klee)

After about 100 kilometres and two bends, the longest straight road of Australia and the second longest unswerving road on Earth began. The longer we drove the more the trees started to get smaller and finally there weren't any trees anymore.

Fig. 71: Andy and Lola at work (Photo F. Moergeli)

Unfortunately, there were loads of dead kangaroos on the road, which got hit by cars or road trains. Andy and Lola started to pull them off the tarmac to prevent that birds of prey feeding of the carcasses got run over as well. This is a standard practice that everyone concerned about wildlife should follow.

Fig. 72: World's highest jump on Australia's longest road (Photo F. Moergeli)

Fig. 73: View from Madura Pass over the Roe Plains (Photo T. Klee)

In a small road house in Balladonia some parts of the Skylab space station were exhibited. The space station was supposed to come down in the Indian Ocean, but finally it spread its parts over Western Australia in July 1979. There are doubts that the entire part of Skylab in the picture (Fig. 80) is original as it seems unlikely that the black plastic door opener survived the re-entry into the atmosphere.

Near Madura Pass we had a great view from the top of a rock cliff over the Roe Plains. The cliff divides two tectonic layers on a stretch of about 300 kilometres. At this point the road was going down from the upper to the lower layer, forming the sweeping Roe Plains.

We arrived in Eucla after about six hours of driving. However, there were lots of opinions in Eucla on what time it was now. There were theories of a time shift of 90 minutes, two hours, or one hour and 45 minutes. In the end it was the one that seemed most unlikely: we lost 45 minutes by driving towards the east.

in Eucla there were lots of opinions on what time it was. There were theories of a time shift of 90 minutes, two hours, or one hour and 45 minutes.

Fig. 74: Confusing time zones around the WA – SA border (Photo M. Kneubühler)

Fig. 70: 360°-view of the longest straight road in Australia (Photo T. Klee)

Fig. 75: The telegraph repeater station at Eucla (Photo J. Sturm)

Fig. 78: Arched doorway almost reclaimed by sand (Photo J. Sturm)

For the first time on this trip we encountered hard camping ground! The Eucla Caravan Park proved to be a test for the quality of our pegs and differences between 50 CHF hovels and MSR tents became obvious. Because everyone had to use the (mc) hammer to set up the tents, some tough guys invented the 'hammer throw and catch game' to speed up the hand-over process. Fortunately and quite surprisingly, neither animals nor humans and cars got harmed.

Before dinner we drove down to the beach, where we could examine our first Australian overland telegraph station. The last stretch to the Southern Ocean we had to slog over sand and dunes and after about 20 minutes we finally reached a beautiful beach, having some similarity of beaches at the North Sea.

The day ended with a nice spaghetti bolognese meal prepared in a rather impromptu kitchen shelter, shielding us from the cold wind.

Fig. 76: Eucla beach (Photo T. Klee)

Fig. 77: Daniel on the old jetty at Eucla beach (Photo A. Hueni)

Fig. 79: Enjoying a stroll along Eucla beach (Photo A. Hueni)

Skylab

Tobias Klee

Skylab was the first Space Station of the US. Its life duration was from 1973 to 1979. After the Apollo missions, NASA sent their first space station into the orbit using the Saturn V rockets that were used for the Apollo Missions as well. The Skylab station was already completely built on Earth. All the food, oxygen, medication and other necessities were already aboard [1].

There were three missions where astronauts lived in Skylab for one to three months. They were mostly observing the Earth, testing impacts of a longer time of zero gravity on the human body and observing the sun with the Apollo Telescope Mount. The first two missions had also to do reparation work outside the Space Station.

With time Skylab's orbit got deeper and deeper because the velocity of the Space Station got smaller due to the Earth's atmosphere. The spaceship of the last Skylab mission was pulling the station to a higher orbit in 1974. Because there weren't any other plans for Skylab, and because the technology was old (it wasn't possible to fill up gases or liquids) NASA decided to let the station crash. The aim was that Skylab would mostly break apart and burn out in the atmosphere. The rest of the parts should come down in the Atlantic and Indian ocean. But because the breaking apart was later than expected, parts of Skylab came down in Western Australia around the shire of Esperance [2, 3]. Fortunately, no people were harmed. A fine of 400 $ was sent to NASA for littering on the territory. The fine was never paid.

In an small road house in Balladonia (WA) some debris of Skylab are exhibited. But there are doubts about the true origins as there was a door handle of plastic that shouldn't have survived the re-entry to the atmosphere.

Fig. 80: Part of Skylab, supposedly having fallen from the sky, but the shiny surfaces let us doubt it (Photo M. Kneubühler)

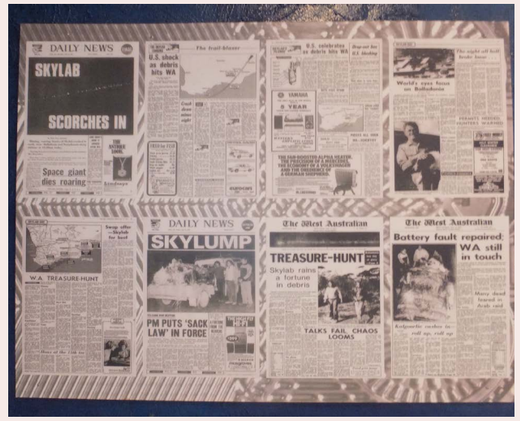

Fig. 81: Fading newspaper articles of the "skylump" (Photo M. Kneubühler)

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The Australian overland telegraph line

Joan Sturm

Back in the days, Australia was far away from its mother country England. In fact it was far away from everything, isolated from the rest of the world. It took up to half a year for a message to reach Australia at the beginning of the 19th century. The newspapers in New South Wales reported the death of Charlotte, Princess of Wales who died on the 5th of November 1817, as soon as they heard of it on the 2nd of April 1818. The news had to travel by horse, ship and mail coach. The situation was not much better within the country. It is a huge land mass with relatively few inhabitants. The distances between cities are enormous and without radio, airplanes or even roads it took weeks or even months to hear about birth or death in the family, to transfer money into a bank or to call for emergency assistance until the 1870's.

Fig. 82: Map of Australia showing Stuart's route through Central Australia 1862 [2]

In 1844, Samuel Morse developed the Morse telegraph and with it the potential to revolutionize the news network and massively speed up the transmission of messages. The new technology was installed in Australia's southeast. Still, receiving news from Europe relied on shipping and took about 60 to 80 days each way. In 1866 the first long-distance undersea cable was laid across the Atlantic Ocean. This was the chance Australia was waiting for.

Several expeditions took off and explorers like Burke and Wills or John McDouall Stuart raced against each other to find a north-south route through Australia to connect an undersea cable installed in the north with the more inhabited areas in the southeast. Although his first attempts failed, John McDouall Stuart managed to find a route from Adelaide to Darwin and come back in 1862. The base for an overland telegraph line was laid but politically it was not yet determined which territories would accept the tender to build the line. The British Australian Telegraph Company (BAT) had decided to link Australia to the rest of the world through a cable from Java to Darwin. Charles Todd, the South Australian Superintendent of Telegraphs, convinced the South Australian government to build the line along the Stuart route and the work began in 1870. A contract with the BAT set the finishing date for the Overland Telegraph to the date the installation of the undersea cable would be finished on the 1st of January 1872 [1]. Todd had only two years to transit the inhospitable land of Australia's centre, erect thousands of poles in hand dig holes 250 metres apart from each other and lay 3'000 kilometres of galvanised telegraph wire. Afghan camel trains were contracted to keep up supplies and build small settlements around the 11 repeater stations. Todd's project planned to work in three sections, the only way to complete the telegraph line in such a short time. While the southern sector was least of a problem, Todd was confronted with finding the right route in harsh environment on the middle section and replacing the whole team working on the northern part because the previous team all went on strike due to the though conditions during the wet season. These problems led to a delay. Charles Todd did not meet the contract

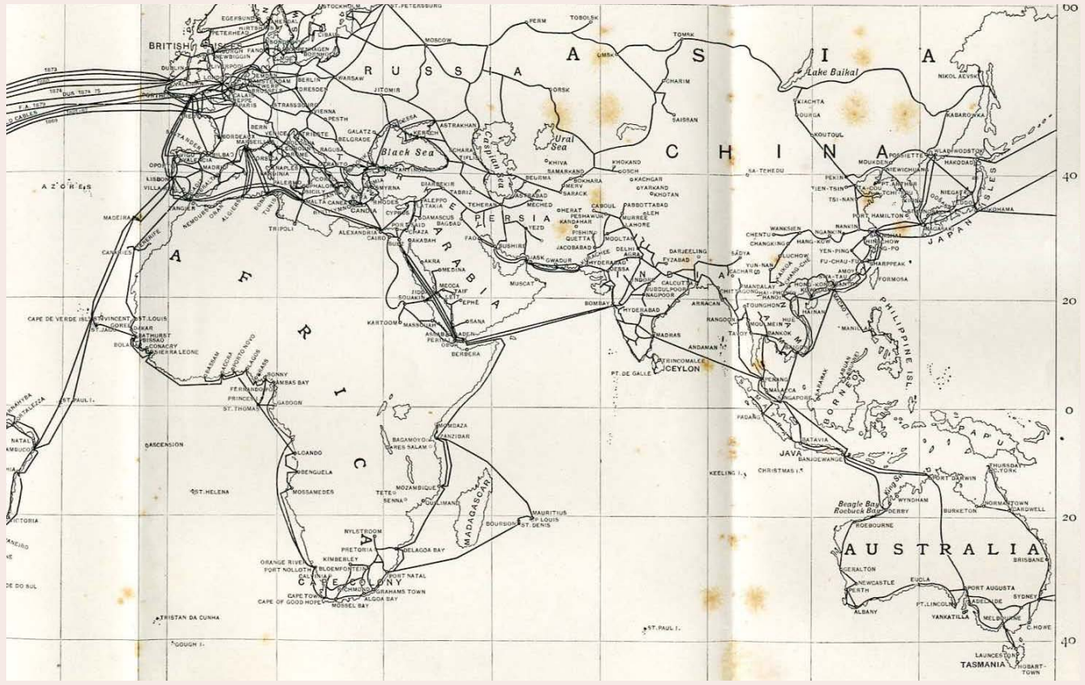

Fig. 83: Cable routes and principal land lines of the Eastern Telegraph Company in 1890 [3]

as the telegraph line was not finished on the 1st of January 1872. A pony express was installed to carry the messages to the place where the telegraph line was already working. On the 22nd of August 1872 the Overland Telegraph was finally completed. Australia was connected to the rest of the world. The Australians could now receive a message from London in Adelaide in about seven hours.

"No line passing through a similar extent of uninhabited country, where the materials had to be carted over such long distances, no line of equal length and presenting similar natural obstacles, has been constructed in the same short space of time." Charles Todd, 1870.

During the second World War Darwin was bombed by the Japanese in 1942. Out of fear of an invasion the international cable was cut. It was never repaired afterwards as new technologies, such as radio and airmail made the telegraph redundant after the war. Within Australia the telegraph line remained in use until the 1970's, when it was replaced by microwave links. The Australian overland telegraph remains in a state of disrepair, a tourist attraction and foremost a legacy. A legacy of conquering the tyranny of distance and ending Australia's isolation from the world. It tells the story of challenges, politics, people and achievement.

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Eucla - Ceduna

Day 7, 23 January 2016

Fabienne Maag

We had to get up early in the morning to pack our luggage and prepare breakfast. Thus our alarm was set to 6 o'clock. At 8:15 we started our trip after a short refueling stop at the gas station of the Caravan Park. We did not have to stop at Border Village [1] because this control point was only relevant for travellers from east to west whereas the control point for a journey crossing the border from west to east was located in Ceduna. Only a few kilometres after Border Village we had a first photo stop to enjoy the view on stunning cliffs.

Only a few kilometres after Border Village we had a first photo stop to enjoy the view on stunning cliffs.

After 197 kilometres of driving along the southern coast of Australia we reached the Nullarbor Roadhouse. This roadhouse indicates the western end of the treeless plain. This so called Nullarbor Plain is a limestone area of around 200'000 square kilometres situated in the Great Australian Bight [2-4]. Its name comes from latin 'nulla arbor', meaning 'no trees' and fits perfectly because in this area of southern Australia nearly no tree can be spotted. The area is the world's largest single exposure of limestone bedrock. In this area one can also find the world's longest straight road, a completely straight part of the Eyre Highway with a length of 146.6 kilometres.

Fig. 84: Not one of the huge and loud road trains but an oversized truck on Australia's longest straight road (Photo S. Bertschi)

In the Nullarbor Roadhouse we also had to adjust the time on all our clocks because we had entered once again a new time zone. During our stop we realised that it really could matter in which car one was travelling. Mathias in the first car was driving straight ahead (maybe too fast because he was never using the cruise control?) and promply missed an indicated photo stop and Joan, Luca and me sitting also in the car did not think it would make any big difference on this day's highlights if we would not stop on this single outlook. But unfortunately, we did not realise that it would absolutely have made a difference! In contrary to the others, we could only marvel at the wild dolphins on pictures whereas the rest of our group has seen them in real.

Fig. 85: Being careful at the Bunda Cliffs as they are prone to break! (Photo S. Bertschi)

After one hour of driving we reached a parking spot and a tourist office with an entry to a section of the Bunda cliffs. On this parking area we corralled our wagons and prepared our lunch in their shades. After we had enjoyed our lunch consisting of our beloved wraps, some of the group entered the tourist office prepared with binoculars and cameras to start a short excursion within the expedition. We paid the entrance fee of fifteen dollars and walked closer to the

Fig. 86: Bunda Cliffs (Photo D. Fawcett)

Bunda cliffs. These cliffs are composed of limestone, which extends far inland. The cliffs range in height between 40 to 80 metres and stretch west for 800 kilometres.

On this coastal stretch of Australia the cliffs are formed of three distinct units of limestone. A light coloured base, the so-called Wilson Bluff Limestone, was formed when the sea levels were higher and the Southern Ocean inundated southern Australia. The next cliff layer is the Nullarbor Limestone which began forming around 25 million years ago. This layer formation was again driven by inundation and sedimentation. The top layer is the so-called Bridgewater Formation which formed between 1.6 million and 100'000 years ago. This top layer consists of hardened windblown calcareous sand.

After we had enjoyed our lunch consisting of our beloved wraps ...

After our lunch break and the short walk to the Bunda cliffs we had to reorganize the cars and their passengers. Two cars should drive directly to the new campground and carry out a shopping action whereas the other two cars with all students that wanted to have a bath and beach stroll headed for the famous Cactus Beach.

Fig. 87: Dolphins close to limestone cliffs in the Nullarbor Plain (Photo D. Fawcett)

Fig. 88: Singing Honeyeater (Gavicalis virescens) on the trail to the Bunda Cliffs (Photo F. Maag)

Fig. 89: Sand dunes on the way to Cactus Beach (Photo J. Sturm)

On the way to Cactus Beach we stopped several times, once to glance at a lizard, once to finally get a good picture of a road train with the driver sleeping in the cabin, and further ones to enjoy the incredible environment on the way to Cactus Beach.

After we entered a gravel road we saw an amazing salt lake with sediments of red colour. Of course, as real geographers at least one of us (in this case me) had to taste it, as we learned in our physical geography courses, if it is real salt. I can confirm that it absolutley tasted salty!

Directly on the other side of the salt lake we could see impressive high sand dunes with some green vegetation. As one can imagine we needed a certain time until we finally reached Cactus Beach because we had to stop at various photo spots. Thus, we required quite some time to cover this relatively short part of the way. The only thing that led us to hurry up a little was the smell, which was, contrary to the view, nothing to be remembered …

When we finally arrived at Cactus Beach we first had to walk down a boardwalk before we could stroll over nearly white sand. But this sand did not form the whole beach so we had to manoeuvre over limestone rocks dotted with waterfilled holes. On these rocks we could already collect different kinds of shells, however, some of them were still used as accomodation by the crabs living in them. In the relatively shallow water only three of us went swimming whereas the others could observe curious seagulls, collect more of the shells or just enjoy the view. After our three intrepid swimmers had returned from their venture to the beach we saw something in the water, which may have been a sting ray. But unfortunately, all our efforts to get a photo of it failed.

Directly on the other side of the salt lake we could see impressive high sand dunes with some green vegetation.

Fig. 90: Licking-test to ascertain that a salt lake really tastes salty (Photo D. Fawcett)

Fig. 91: Cactus Beach (Photo D. Fawcett)

Thus, we returned back to our cars with some shells in our pockets and sand everywhere.

Before we continued on our way to the campground we had a small snack consisting of Doritos, salt and vinegar crisps and salsa on the parking area of Cactus Beach. On the way to the campground we could see a lot of agricultural land where corn was planted but also areas with cows and sheep grazing. On our way, we had now to pass the border control shortly before Ceduna. Here we had to hand over our last avocado, which was still too hard to be eaten but surprisingly, we were allowed to keep the onion which we still had. Thinking of guacamole, the border guard asked us through the whole recipe twice to check if we had any of the other ingrediences and he was flabbergasted that we only had one onion and one avocado left! What we did not tell the border guard was that we were bringing a certain amount of soil with us into South Australia from the day Andy's car got stuck in the mud because he still had not cleaned the footwell of the car... But luckily the guard did not glance into the car and thus would never know how much „forbidden" material we brought with us from Western Australia, which had mostly been „collected" during the towing exercise of Andy's car a few days ago.

On our way, we had now to pass the border control shortly before Ceduna.

On reaching the campground we started to pitch the tents and cook our dinner. One important member of the cooking group this evening was of course Luca, who was responsible for all sorts of barbecue, grilling any meat or vegetables. This evening we enjoyed delicious chicken burgers and a tomato cucumber salad. After cleaning the kitchen, one part of the team had a relaxed evening on the camp ground whereas another part was sitting on the sand dunes, located directly behind our tents. There we drank some bundabergs and beers, talked about the past day as well as the coming ones and had an amazing view of the sunset over the ocean and later of the rising moon. Finally, wanting to express our feelings in this wide country we howled to the moon.

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Fig. 92: Sunset in Ceduna observed from the sand dunes behind the campground (Photo D. Fawcett)

Fig. 93: Early sunrise in the outback with hundreds of flies on the arms and hands of the photographer (Photo S. Bertschi)

Geology of Western Australia

Sonja Bertschi

Australia is known as the “oldest” continent on Earth with the oldest minerals and rocks. However, rocks of other continents are not much younger. The difference lies in the fact that much of Australia’s rocks have only been marginally rejuvenated by metamorphosis, volcanic and seismic activity. More than half of the surface rocks of Australia formed far more than 600 million years ago [1].

Western Australia (WA) holds many astonishing records: The geological evolution of Western Australia spans over more than 4 billion years of Earth’s history. The East Pilbara region in the northwest of Western Australia has one of Earth’s best-preserved remnants of ancient crust — estimated to be more than 3.5 billion years old.

Although the oldest rocks on Earth are found in Canada and are dated 4’030 million years old, the oldest minerals (zircons) have crystallized 4’404 million years ago and are found in WA. The oldest rocks in WA are highly deformed gneisses from the early Archaen Eon (4’000 – 2’500 Ma). The oldest stromatolites and bacterial fossils identified on Earth have been found in Archean rocks from the Pilbara Craton. Today, modern stromatolites grow slowly, around Hamelin Pool at Shark Bay, a World Heritage Area (see page 15). These ‘living fossils’ are the descendants of some of the mentioned stromatolites, the earliest forms of life that developed on Earth. Continental blocks continued to grow and world-class gold (Kalgoorlie, see page 22) and nickel (Kambalda) deposits in Western Australia were formed during the late Archean Era [2, 3].

During the Paleoproterozoic Era (2’500 – 1’600 Ma), the original Pilbara and Yilgarn granite blocks were successively joined by other blocks of granite that rose above sea level. Also, massive intrusions of granite between the original blocks were formed and many of the major banded iron formations in WA were deposited. Banded iron formations are sedimentary rocks which are one of the most important precursors to the formation of economic sources of iron ore. Some of the world’s largest deposits of iron, lead, zinc, silver and uranium were also formed in this Era. Later in the Proterozoic Eras (1’600 – 541 Ma), rock forming and mineral deposit processes were more relevant to the central and eastern parts of the continent [1, 3].

Major oil, gas and coal deposits were formed in Australia throughout the Mesozoic Era (541 – 252 Ma). During the worldwide Permian ice age, Australia was covered with large amounts of ice, more than ever again. Glaciers were a major factor for shaping the topography of the Great Western Plateau. The current inland landscapes of WA result from erosion since then. The basins in the region were subsequently shaped by the retreat of the seas that covered them in the Cretaceous [1, 3].

Main tectonic units of Western Australia

Our journey across Western Australia started on the geologically youngest, Quartenary (up to 10 Ma) eolian and alluvial deposits in the Perth region with coastal, river-valley and forested hilly landscapes [4].

For the longest stretch, we’ve travelled for many hundreds of kilometres on the Archaen Yilgarn craton. It is in this ancient, mainly flat crust where most of the ore deposits are found.

The geologically “young” Eucla basin, which forms the underground of the Nullarbor plain consists of marine and coastal deposits (carbonate rocks) and was formed 30 – 20 Ma ago in the Cenozoic. The succession over the main part of the Eucla Basin was initially of calcarenite (limestone) formed at depths of about 100 m, and was followed after a slight disconformity by an algal limestone, then a hard, abundantly fossiliferous calcarenite (Nullarbor Limestone) that forms the main surface of the Nullarbor Plain (see Fig. 86 on page 45 where this succession can be seen at the cliffs). Along the southern margin, major headward erosion of the limestones formed a prominent sea cliff extending continuously across the Great Australian Bight at a length of over 900 km. There are numerous caves in the limestone underlying the Nullarbor plain, many going down to the watertable [5].

Geomorphology and landforms

All major landscapes were formed more than 90 Ma ago - well before the orogeny of the Himalayan and European Alps - making them more ancient than most places in other parts of the world. In the middle of flat expanses of land, granite outcrops, salt lakes and spectacular “breakaways” – inland cliffs that have been broken away by wind and water erosion – determine these typical Australian landscapes.

An important part of Western Australia’s ancient landscape is the regolith. Regolith includes soils, the weathered bedrock, materials moved downhill, transported alluvium and windblown sands and also salt lake sediments. This weathered blanket of material covers bedrock and contains large and valuable mineral resources, the extraction of which forms a fundamental part of the State’s economy [1, 2, 5].

Australia has been subjected to very little tectonic activity since the seas of the Cretaceous retreated, with only minor episodes of uplift or subsidence. Today the continent is tectonically stable and has no active mountain building or major fault system. But despite the stability of the plate, there are small earthquakes (intra-plate tectonism) [1, 2].

Except for the coastal regions, the water drainage systems in Western Australia today represent the remnants of major river systems that were active millions of years ago, when the hills were higher and the valleys well defined. The landscape now is too dry and flat to channel flows, and the watercourses are rarely well defined and end in flat salt lakes which eventually dry out [2].

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Ceduna - Port Augusta

Day 8, 24 January 2016

Sondra Tjin

As usual, our daily wake up time was early. Around 8 am, we had already had a good breakfast and packed up all our camping gear. We were ready to leave Ceduna Shelly Beach Caravan Park for our next destination: Port Augusta, around 470 kilometres over the Eyre Highway to the east of Ceduna. It would be another long day of driving.

Shortly after Ceduna, we passed through a landscape of ample pastures and cornfields. The region is known as a long-drawn wheat belt. However, much of the corn was already harvested and many pastures were cut. Sporadically, we saw some trees and bushes along the road and on the fields, probably to provide some shadow for the cattle.

As usual, our daily wake up time was early. Around 8 am, we had already had a good breakfast and packed up all our camping gear.

We drove towards the next villages, Wirulla and Poochera, where we entered the Granite Country. In Minippa we left the main road for our first highlight of the day. Since the famous Wave Rock in Western Australia was not on our route, we were really looking forward to see a smaller wave rock formation, the Pildappa Rock.

Once we arrived, we all climbed up the huge red granite rock. The Pildappa Rock is an inselberg that belongs to a larger sedimentary rock formation. The former environment of the inselberg has been eroded by water and wind (see the respective theme box for information).

From the top of Pildappa Rock we had an amazing view over the surrounding landscape and could, amongst others, see the Gawler Ranges National Park in the northeast. We climbed the rock without really thinking about it. Only when we were standing on the top and enjoying the stunning view, some of us were thinking of the possible aboriginal meaning of the rock. There were no signs and the Wudinna District Council even suggests climbing the rock for the view. However, climbing rocks with aboriginal meaning, such as the Uluru, should be avoided as it disrespects their culture. (Doing some research after the visit, I did not find anything about restrictions on climbing the rock.)

Fig. 94: Rock Wave of the Pildappa Rock (Photo J. Sturm)

Fig. 95: Blue Tongue Lizard (Photo S. Tjin)

On our way back to the main road, we encountered a blue tongue lizard on the track. We stopped and got out of the car to have a closer look at this interesting reptile.

Our lunch break was somewhere along the road and on the menu was the usual: wraps, dips, fresh veggies, fruit, cold meat. Only Christoph and Andy had something more special. Christoph ate his apple with peanut butter and Andy had a cheese, peanut butter, olive dip and veggie sandwich… some unusual combinations, but they enjoyed it. After lunch we followed the long straight Eyre Highway past Kyancutta.

Fig. 96: Group wave on Pildappa Rock (Photo J. Sturm)

For the afternoon, another stop that promised a nice view was planned. We drove up to the Whites Knob Scenic Lookout northwest of the village of Kimba. After the amazing view in the morning, this lookout point was a little bit disappointing and we were only moderately enthused by it. So we drove on towards Port Augusta and saw how the vegetation again changed. The landscape got sparser and there were fewer trees and more bushes instead. The trees that were still around were less high. Passing Iron Knob, we also encountered the vast deposits of mining operations.

Earlier than usual, we arrived at our next camping site, the Big4 Holiday Park in Port Augusta. After one week of traveling, we all had some laundry to do. But the early arrival not only gave us time to do laundry and groceries, it also allowed us to relax for a while, on the campsite or in the pool.

After a delicious barbeque dinner some of us lay on the ground to gaze at the many stars and search for the Southern Cross, Orion Belt and other constellations.

Fig. 97: Mining operations near Iron Knob (Photo S. Tjin)

Fig. 98: Stunning view from the top of Pildappa Rock over vast agricultural areas to the distant peaks of the Gawler Ranges NP (Photo S. Tjin)

Geology in South Australia: Inselberg Pildappa Rock

Sondra Tjin

An inselberg is a typical formation appearing in deserts. It is an isolated hill that belongs to a greater geological formation and appears to rise from the ground like an island. Inselbergs have a dome or castle like form and are relict features that have remained while the surrounding landscape was lowered. The inselberg has a more resistant body rock compared to the surrounding landscape, which has been eroded due to subsurface weathering processes [1].

The Pildappa Rock is an inselberg located in the Granite Country of South Australia and was formed approximately 1.5 billion years ago. It is part of the vast Gawler Craton, which consists of a geological shield structure covering the central Eyre Peninsula, the Gawler Ranges and large parts of South Australia's outback. In geologist's terms, the Pildappa Rock as well as other inselbergs in the area belong to the pink granite Hiltaba suite of rocks dating back to the Eyre Peninsula's Precambrian age [2].

The inselberg's granite dome was formed around 7 kilometers below the Earth's surface. Over time, much soil erosion due to weathering has occurred [3, 4]. However, numerous studies have found out that the Pildappa Rock has a surface erosion rate not greater than 50 centimeters per one million years, which indicates an extraordinary stability [5].

The peculiar wave or flared slope of the Pildappa Rock is a consequence of complex chemical weathering below the surface. Water seeps into the soil and over time the water and permanent moist soil conditions act together and chemically weather away granite minerals. Other typical inselberg landforms like decaying granite sheet structures, minor tafoni forms and water holes are present [3]. After rainfalls, the water availability is quite high. The Pildappa Rock was therefore an important watering point in the late 19th and eartly 20th century when the livestock migrated to the winter grazing grounds in the Gawler Ranges [2]. It was also used by early farmers to harvest water running off the rock dome when it rained [4].

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January 2016 weather in comparison to the long-term average climate

Melanie Graf

Place/Region	Perth	Kalgoorlie	Nullarbor	Coober Pedy	Oodnadatta	Adelaide
Sea temperatures	21°C	-	20°C	-	-	19°C
Average temperature	25°C	26°C	21.9°C	29°C	30°C	23°C
High temperature average	31.1°C	33.7°C	27.9°C	36.8°C	37.9°C	29.4°C
Low temperature average	18.1°C	18.3°C	15.8°C	22.3°C	23°C	18.9°C
High record-range (Daily)	43.3-19.7°C	46.5-14.4°C	48.5-19°C	47.4-21.6°C	50.7-15.7°C	45.7-17.6°C
Low record-range (Daily)	29.7-8.9°C	30.4-8.8°C	28.5-3.5°C	33.6-12°C	11.7-34.2°C	33.9-9.2°C
Days over 30°C	17.5	23.3	8.9	28.2	28.5	13.4
Relative Humidity	48%	43%	38%	18%	22%	33%
Rainfall	10mm	8.4mm	2.4mm	4.2mm	7mm	20.1 mm

Table 1: Long-term climate statistics for January for selected locations along the excursion route

Western and South Australia are some of the driest and hottest places to visit in January. As 2016 was an El Niño year, temperatures were expected to be higher than average across the whole country. However, little was known beforehand on how the effect would influence local temperatures, especially in central Australia.

Table 1 lists the long-term climate statistics for the excursion travel route. According to the monthly weather report of January 2016, the temperature and precipitation diverged remarkably from the long-term average all over Australia (Table 2). But while it was much warmer than normal in the eastern and north-eastern parts of the continent, Western Australia and the Northern Territory experienced maximum temperatures that were lower than the long-term mean. Still, statistics show that all of the temperatures were above the long-term average.

Due to unseasonal thunderstorms in the region there was also a much larger total precipitation than expected. At multiple locations across the country and especially in WA monthly rainfall records were broken in January 2016.

This caused a rather uncharacteristic experience as on the travel route we encountered maximum temperatures around 40°C only twice, and for several days the peak temperature was well below 30°C.

These deviations from the average do not contradict the strong El Niño event, as the average temperature was still well above the long-term average. However, the increased precipitation in WA was not expected, and the low maximum temperatures in WA were not necessarily due to El Niño [1, 2, 3]. Other theories suggest that more rain in inland WA could in fact be caused by El Niño and may be related to an effect called "Indian Ocean Dipole" [4].

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Country/Region	Rainfall anomaly	Mean maximum temperature anomaly	Mean minimum temperature anomaly	Mean temperature anomaly
Australia	-8%	+0.21°C	+0.83°C	+0.52°C
Western Australia	+27%	-0.29°C	+0.62°C	+0.17°C
Northern Territory	-33%	-0.11°C	+0.26°C	+0.07°C
South Australia	+2%	+0.38°C	+1.28°C	+0.83°C
Queensland	-26%	+0.82°C	+0.87°C	+0.85°C
New South Wales	+33%	+0.38°C	+1.29°C	+0.84°C
Victoria	+62%	+1.04°C	+2.01°C 7th-highest	+1.53°C
Tasmania	+30%	+1.89°C 7th-highest	+1.69°C 3rd-highest	+1.79°C 2nd-highest

Table 2: January 2016 weather statistics [3]

Port Augusta - Coober Pedy

Day 9, 25 January 2016

Christoph Rohner

With another high-mileage day ahead, the wake-up call was again quite early. After more than a week of tenting experience, the morning routine with showering, breakfast and stowing the gear in the trunks was done in a jiffy. Around half past eight the convoy of cars quickly fuelled up with gas and caffeine before hitting the road towards north, looking forward to a first encounter with the famous outback.

The first stop of the day was scheduled for Pimba, two hours north of Port Augusta. Pimba is a small settlement consisting of 50 persons and – more importantly – Spud's Roadhouse, where – once again – both fuel and caffeine tanks were filled. Even though there were no other travellers in sight on the parking lot, we were anything but alone: the Australian Outback Air Force (a.k.a. flies) were waiting for us and greeted us frenetically – a mild foretaste of what the outback still had up its sleeve.

This one hour drive was quite uneventful, except for some dust devils visible in the distance.

Before leaving Pimba, we agreed on continuing our trip until the settlement of Glendambo. This one hour drive was quite uneventful, except for some dust devils visible in the distance.

The location of our lunch stop in Glendambo allowed a view over one of Australia's biggest endorheic salt lakes, Lake Gairdner, while preparing the vegetables, meat, cheese and dips needed for a novelty menu: wraps. But why change a winning team?

Invigorated from the meal, the convoy continued towards Coober Pedy. Again, the drive was uneventful until just before Coober Pedy, where we encountered a flashing police car parked behind another car at the side of the road. Dutifully (and ensuring that the speed limit of 110 km/h was not exceeded) the lane was changed before passing the car and soon after, we arrived in Coober Pedy, the self-proclaimed opal capital of the world. The thermometer outside our backpacker's inn showed a temperature of 35°C, which might be one of the reasons why almost all buildings in this desert town are built below ground in old opal mines – as was our accommodation. While we were gathering our

Fig. 99: Spud's Roadhouse in Pimba (Photo D. Fawcett)

Fig. 100: : Lake Gairdner (Photo S. Bertschi)

stuff from the cars, we realized that there were only three cars parked. And for once it was not Daniel missing but Mathias. After about 15 minutes he finally arrived, but at least with a good excuse: just like the three cars before him, he passed the police car, but was pulled over by it soon after.

The reason: section 83, subsection 1a of the South Australia Road Traffic Act. According to this act, "A person must not, while driving through an emergency service speed zone, drive at a speed greater than 25 kilometres per hour". Given the fact that it was the eve of Australia Day and the officer

Fig. 101: While some are just standing around, pretending to watch the landscape for predators … (Photo M. Kneubühler)

Fig. 102: … others are actually working, preparing lunch (Photo M. Kneubühler)

Fig. 103: Dust devil between Pimba and Glendambo (Photo D. Fawcett)

Fig. 104: Overlooking Coober Pedy (Photo M. Kneubühler)

was in a good mood, Mathias got off with a friendly education about the above-mentioned part of the Road Traffic Act, which he then passed on to the rest of the drivers.

Given the fact that it was the eve of Australia Day and the officer was in a good mood, Mathias got off with a friendly education.

Fig. 105: The Radeka Down Under Backpacker Inn (Photo J. Sturm)

After checking into the backpackers, there was time for a short stroll around town as well as for some grocery and opal shopping. While strolling around, someone discovered a reconstructed, although still broken Star Wars spaceship, which – despite our mechanics' best efforts – we could not get to run again. Slightly disappointed after this failure, we headed for John's Pizza Bar, one of the few open restaurants in town (apparently January is low season in Coober Pedy), where we enjoyed a delicious meal, before heading back to the backpackers and letting the day sink away playing games and having a drink.

Fig. 106: The reconstructed Star Wars spaceship (Photos M. Kneubühler)

Satellite data for Australia

Melanie Graf

Satellite data are very important nowadays in Australia for multiple purposes. While initially used for mapping purposes, real-time services like hazard monitoring and applications in geosciences have come much more into use lately. As the short history of satellite data in Australia shows, the country has not had its own satellite programme to this day. But it was fortunate enough to negotiate very favourable deals with other countries' programmes like Japan's and the US', so that they have a wide range of data at their disposal [1].

Just recently, the European Space Agency (ESA) has ensured Geoscience Australia access to EU's Sentinel data. The collaboration with the EU through the Copernicus data access infrastructure will not only make data available for Australia, but will also allow for better interaction between scientists on both sides. With this, the EU seeks to use the acquired data to their full potential and Australia gains a tremendous source of data, which can be especially helpful in observing environmental issues in highly populated areas. This can lead to better protection from natural disasters or to promote sustainable natural resource development.

The longstanding calibration services provided to other satellite programmes, like on Lake Lefroy, offered by CSIRO amongst others have helped Australia immensely to gain respect and make fortunate arrangements with these other programmes [2].

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1972
First Earth monitoring satellite launched by the United States Government

1979
Alice Springs Ground Station built with support from United States Geological Survey

1980
Alice Springs Ground Station starts downloading satellite imagery over Australia for land use

1990s
Satellite imagery starts being used for mapping and agriculture

2000s
Satellite imagery starts being used for environmental and natural hazard monitoring

2010s
Satellite imagery starts being used for water security

Fig. 107: Milestones of Earth Observation data usage in Australia [3]

ASTER map of Australia

The US Terra satellite was launched in 1999 and started to collect remote sensing data using imaging instruments like the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) ever since.

The ASTER sensor collects Earth surface data with high spatial resolution.

Using the provided Visible and Near Infrared (VNIR) with a resolution of 15 m and Shortwave Infrared (SWIR) with a resolution of 30 m, a continental mosaic of a geological map of Australia could be generated [4].

ASTER allows mapping the distribution of various minerals, carbonates, clays, alunite and iron oxides. This offers many opportunities for geoscience research applications as well as more commercial applications like mining exploration [5].

The remote sensing mapping method also makes geological mapping a lot easier than it was before when using traditional methods.

Fig. 109: Panoramic view over Coober Pedy from a downtown lookout on top of an artificial hill of mining deposits (Photo S. Bertschi)

Opal mining in Coober Pedy

Fabienne Maag

History of Coober Pedy

The name Coober Pedy originates from the Aboriginal words kupa piti, meaning ‘white man in a hole’ and describes exactly what industry shaped the development of this city the most [1, 2]. In 1915, Jim Hutchinson, his son and two other men were travelling from Adelaide to Alice Springs and dug for gold. But instead of gold, Hutchinson’s son found opals lying on the ground [2]. And already eight days later, they had the first opal claim pegged in this area [1]. In 1917, the Trans Continental Railway was completed and some of the construction workers as well as soldiers returning from World War 1 came to the opal fields, introducing the unique method of living underground in "dugouts" to escape heat and sand storms. As a consequence, beside mining activities and most apartments also a church and various hotels located underground can today be found to avoid the hot summer temperatures and the regularly occurring sand storms [1, 2]. In the beginning of the mining activities, supply with water and food was especially difficult because everything had to be transported over huge distances to the mines and the miners’ camps. Today, an underground source 24 kilometres north of town supplies the water, which is pumped through an underground pipeline to the water works where it is treated by reverse osmosis and further pumped through a reticulated town water supply system [1].

During the Great Depression of the late 1930's and 1940's, opal prices decreased rapidly and the mines were nearly abandoned. The opal discovery of an Aboriginal woman named Tottie Bryant in 1946 started a new rush and the mining activities were increased again. In the 1960’s the mining industry expanded due to the high number of European immigrants hoping to make their fortune in Coober Pedy. Thus, the opal mining developed into a multi-million dollar industry [1] and Coober Pedy is today known as the world’s largest producer of opals. Together with Andamooka and Mintabie (also both located in South Australia) it produces 85% of the world’s opal volume [3], whereas Cober Peedy alone is responsible for around 70% of the worldwide opal production [2]. In a 40 km radius around the city, covering an area of around 5’000 square kilometres, shafts and mullock heaps from opal mining activities can be seen everywhere. Today, the population of Coober Pedy is estimated at around 3’500 people [3].

In recent times, Coober Pedy became also a regional service centre in the Southern Australian Outback for services like medicine, welfare, law and order and education. Today, a golf court exists in Coober Pedy, too, of course without any grass. Hence, each golfer is asked to bring a piece of green to each game that can be used as tee [2, 3].

Fig. 108: Shafts and mullock heaps around Coober Pedy (Photo J. Sturm)

Opal forming and mining

The area of Coober Pedy was covered by an ocean around 150 million years ago, and silica minerals from the seabed were deposited in the cracks of the ground [3]. To form an opal, water has to be included within the mineral structure beside the silica spheres, too. The colour is caused by the regular array of the silica and existing voids in the structure, which break the light into different colours of the spectrum [1, 4]. The diameter of the silica particles and the spacing between them determines the colour range of each opal. Smaller spheres with ranges between 150 nm to 200 nm give the opal a blue colour whereas spheres around 350 nm generate red colours [1]. Through different weathering effects soluble silica was created, as well as cavities in the solid rocks. The silica was deposited over time in these cavities and with periodic lowering of the water table the silica was solidified and consequently formed the multi coloured gem stone in the rock cavities [1, 3, 4].

Today, each miner can claim an area of 50 x 50 m or 50 x 100 m to search for opals after acquiring a mining permission. Earlier, a shaft was dug using pick and shovel. If opals were found a hand pick or screwdriver was used to extract the opals. Today, the shafts are usually created using a drilling machine, which excavates holes with 1 m diameter and a maximum depth of 30 metres. Earlier, the waste or so-called mullock was brought to the surface by hand. Today, truck mounted blowers are often used which work like vacuum cleaners. Especially in big opal mining sites the mullock is then loaded onto a conveyor belt and the material is transported to an area where it is further controlled if any opals can be extracted [1, 4].

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Fig. 110: Opal shop in Coober Pedy (Photo F. Maag)

Fig. 111: Art outside of Coober Pedy illustrating mining equipment and activity (Photo F. Maag)

Coober Pedy - Oodnadatta

Day 10, 26 January 2016

Melanie Graf

Fig. 112: Australian flags on Australia Day (Photo D. Fawcett)

It was Australia Day and travelling through the middle of the Outback, we had a truly Australian day driving through the desert complete with little Australian flags. Australia Day celebrates the history of the continent since the landing of the first ship and the European settlement in the 19th century. Being a national holiday, Australians usually spend the day with festivities like parades, fireworks or barbecues at the beach. In recent history, Australia Day has become a day representing the mixing of the different immigrated cultures, not just of European people but also Asian, African and Pacific Islanders. Especially in the larger cities there are large parades and thousands of immigrants choose this day to receive their citizenship [1]. To honour this national holiday we all wore small Australian flag tattoos.

However, the minority group of native Australians or Aborigines and Torres Strait Islanders have a different view on the history-changing event of the landing of the first fleet. Each year demonstrations are held and at times there are even violent brawls as the day riles up many negative emotions in the native groups.

After an interesting night underground in a shut down opal shaft at Radeka Downunder Backpackers, we travelled north to Oodnadatta. The night temperatures were quite warm, between the high twenties and low thirties, but the caves of our accommodation guaranteed a constant temperature of 18°C all year round. Oodnadatta is the place with the highest measured temperature in Australia with a record high at 50.7°C in the 1960's [2].

The direct route would only have been around 200 km, but thanks to Travis' input we took the scenic route through different desert landscapes. For this we needed to fuel up at the service station, where we encountered two young aboriginal men who voiced their frustration about the day by wishing us a "Happy Occupation Day".

Out of respect for the predominantly aboriginal population in the area around Oodnadatta, we took our little flags down in the settlement.

This little reminder of who this country once belonged to fitted the landscape of this day's travel very well, as we soon

Fig. 113: At the dog fence (Photo J. Sturm)

It was Australia Day and travelling through the middle of the Outback, we had a truly Australian day driving through the desert.

entered aboriginal country. After a few kilometres on the highway, we took a gravel road to the west, where we followed a scenic route through the varied desert.

In the still quite cool summer morning we visited the Breakaways, which are little plateaus that look out over the very flat and dry landscape. These flattop hills

Fig. 114: Informed by Andy and Mathias about the region we are feeling confident (Photo S. Tjin)

have developed over millions of years because of an ancient lake, which covered a very large area of central Australia 70 million years ago. The different layers of sediments are the reason why the hills developed this way.

Oodnadatta is the place with the highest measured temperature in Australia with a record high at 50.7°C in the 1960's.

Because there is no orogenesis in this region in the time span between the deposition of the sediments and today, the layers are still horizontal and have not been inclined. The exposure to wind and water over the years has led to large-scale erosion. This erosion took the lighter material away and left iron-rich black pebbles called gibber behind. Where this layer became thick the erosion slows down and the underlying material is also protected from erosion. Over thousands of years the Breakaways could be formed through this erosion and they make a stunning landmark in the otherwise flat landscape (information taken from on-site info boxes).

We visited three different viewpoints in the landscape and our devoted photographers could catch some of this stunning landscape.

We also had a look at the castle or, as the natives call it, the papa and wati (two dogs and the man). These are two hills, one white and one brown next to each other, which represent two mythical dogs lying down and a peaked hill called the man, who is their supposed owner.

Fig. 115: Trekking to a viewpoint in the painted desert (Photo A. Hueni)

Fig. 116: On the moon plain (Photo J. Sturm)

Fig. 117: The sparsely vegetated, multi-coloured Breakaways (Photo S. Bertschi)

The dogs in this context refer to the dingo, even though no dingo roams this area anymore because of the dingo fence through all of South Australia, Queensland and New South Wales, along which we drove later in the day. As the sun was getting stronger and the temperature climbed slowly over thirty we began to understand, why the dogs needed to lie down and are still idly lying there.

Fig. 118: Formations called "the castle" (Photo D. Fawcett)

After a quick walk on the Moon Plain, which supposedly looks like the moon surface, very flat covered in barren brown rocks, we drove on to find a shady place for lunch. None of us had walked on the moon, but its safe to say most of us weren't particularly impressed by the view. Lunch was more important at that point but since coming to the Outback the flies seemed to have multiplied and as the temperature had risen up to 40°C, we couldn't get back into the cars fast enough.

We continued our journey and after some awkward toilet stops in the open reached another highlight of the day. This beautiful place was called the Painted Desert, where most of us took a little stroll around the hills in the scorching heat, while the rest stayed with the cars and enjoyed a cold Bundaberg ginger beer.

The Painted Desert gets its name from its various coloured hills. These, again, are a consequence of erosion of the ancient lake sediments. The minerals washed out of the rocks give them their different colours [3]. The general area has muscovite-rich rocks that resulted in a glimmering effect on the southern side of the road. On the northern side of the road the muscovite could not be seen. This phenomenon illustrated beautifully the forward-scattering effect of light on certain land cover.

Fig. 119: Lookout over the painted desert (Photo J. Sturm)

Along this entire scenic route we only encountered two other tourists (and one very small dog). And even in a group as large as ours, the vastness of the landscape and absence of people was perceptible.

Though there might not live many people around here, the people that do care very much for their land. It belongs to a few aboriginal tribes and interesting information boxes illustrated how the landscape might seem very empty and barren to outsiders, but people have lived off and with this environment for ten-thousands of years. Therefore, we were careful not to take anything with us except for beautiful pictures and impressions.

Apart from the people there were also 13'000 cows around, even though we only saw some individual lonely cows standing in the shadow of the sparse trees, trying to stay as cool as possible in the desert heat. Observing this made us all feel quite thankful for the comfortable air-conditioned cars…

This beautiful place is called the Painted Desert, where most of us took a little stroll around the hills in the scorching heat.

Anna Creek Station spans an area of nearly 24'000 km², which is more than half the size of Switzerland and therefore the largest cattle ranch in the world. The station belongs to S. Kidman & Co, which own over 110'000 km² of cattle ranch land across Australia. With a cow population density of 0.54 cows/km² it is not surprising that we only saw a few of them.

Due to the increased rainfall in the weeks before, the vegetation in the area that we saw in the afternoon was surprisingly green and plentiful. There were quite a lot of bushes and grass and along the creeks smaller trees managed to thrive. Given the fact that the usual precipitation rates are very low and all the rain of the previous week had already evaporated or seeped away, the creek beds were dry again.

References
[1] www.australia.com
[2] www.weatherzone.com.au
[3] www.thepainteddesert.com.au

Fig. 120: Green-up of the desert with lush grass (Photo D. Fawcett)

Fig. 121: Hookey's Water Hole in the Neales river bed (Photo S. Bertschi)

Fig. 122: The famous Pink Roadhouse in Oodnadatta (Photo D. Fawcett)

We also saw our first large water hole as we crossed the Neales River, but nobody really wanted to have a swim because the water was terribly murky, and even though we knew there are no crocodiles living in the area, it looks like a paradise for stealthy underwater predators.

It was an exhausting but very interesting day as the encounter of so many different landscapes was new to many of us. It thus was nice to eat at the roadhouse and not have to cook ourselves for a change. The staff at the Pink Roadhouse (and it indeed is very pink!) was very nice and they even organized an additional cook for our dinner, even though they wanted to close up early that night. We also got to stay in nice air-conditioned cabins and because there were so little tourists around, we could even have the upgraded cabins with bathrooms inside. In a less nice surprise the all-present flies were now joined by their smaller but even more irritating friends, and led us to go on a mosquito hunt before we could go to sleep.

Fig. 123: Not as relaxing as it looks like: hundreds of annoying flies swarm around our heads (Photo F. Moergeli)

Fig. 124: Enjoying the tasty Oodna-Burger inside the air-conditioned Pink Roadhouse (Photo M. Kneubühler)

Bidirectional Reflectance Distribution Function effects

Andy Hueni

Desert landscapes are an ideal location to observe the fascinating effects of the Bidirectional Reflectance Distribution Function (BRDF). To witness the extreme difference in perceived surface colour and brightness in actual nature renderes the difficulty of BRDF effects in satellite based and airborne imagery much more tangible.

I've had the privilege to experience this phenomenon in various locations on this planet, but never before had I seen the occurance of specular reflection on a landscape level other than on water bodies.

During our drive from Coober Pedy to Oodnadatta we came across some hills that appeared to be covered with shattered pieces of glass (Fig. 125). A while later we stopped to investigate the matter when these shiny fragments appeared closer to the road. We found the ground to be covered with broken sheets of Muscovite (Mica) (Fig. 128).

Fig. 125: A hillside covered with fragments of Muscovite (Photo A. Hueni)

They acted like mirrors, reflecting the light in a forward direction. The effect of this was that the desert appeared covered with highly reflective scene elements when looking towards the sun while being sandy coloured when peering the other way. As our direction of travel lay in the solar prependicular plane one could easily perceive this peculiar effect.

Fig. 127: Andy is enthusistically explaning the specular effects of slabs of Muscovite (Photo D. Fawcett)

Fig. 128: A sheet of Muscovite observed against the sun to check the transparency (Photo A. Hueni)

The transparency of the raw material present in the desert was astonishing. It was thus easy to comprehend why it had been commonly used in the 16th century as an alternative to glass. The Muscovy province in Russia held occurances of sheet mica and hence the name "Muscovy Glass" was coined [1].

Reference
[1] www.mindat.org/min-2815.html

Fig. 126: 180° panorama of a desert landscape where BRDF effects are most pronounced; a larger version of this phenomenal example can be found later in this document (Fig. 143) (Photo A. Hueni)

Wrap up!
The Australian food chain

Joan Sturm

You're not you when you're hungry! And in the Australian Outback there is no way to escape from hungry and disgruntled students or drivers. Therefore, we had to make sure that everybody was fed and we would never come to the point where we were in desperate need of Snickers.

Sandra had the total overview over everything regarding breakfast, lunch, dinner, and all the little snacks in between.

Fig. 129: Sandra's shopping list from the 25th of January

Luckily we had Sandra. Sandra had the total overview over everything regarding breakfast, lunch, dinner, and all the little snacks in-between. Before the excursion started, a big collection of recipes was prepared so that we would never run out of ideas. But we did not even use our vast recipe collection as we had enough ideas when writing the shopping list for the next day. While three of the cars went to the campground after a long driving day, one car went grocery shopping. It must have been a funny picture with Sandra standing in the middle of the store directing three others to fetch all the things on the shopping list.

Fig. 130: Cutting vegetables ... (Photo M. Kneubühler)

Fig. 131: ... and mixing all in a large bowl of tasty couscous (Photo M. Kneubühler)

Fig. 132: Outdoor pasta cooking (Photo M. Kneubühler)

Fig. 133: Great selections at our outdoor buffet (Photo M. Kneubühler)

We had wraps. Everyday. Lunch time was wrap time.

Coming back from the store there were always a few volunteers that helped preparing dinner. A big compliment going out to every participant that we never had to determine who would be helping that day. Some were always there when vegetables had to be cut, pasta had to be cooked or meat had to be grilled, some rather preferred to do the dishes afterwards (probably the better decision for all of us).

Reading the daily reports, you might have come across one or two mentions of wraps. We had wraps. Everyday. Lunch time was wrap time. Wraps are an ideal solution for different tastes. As not everybody likes the same things we could choose from a buffet of diverse ingredients for our wraps. There were five or six different dips, a lot of cut vegetables, cheese, cold meat and the left-overs from the previous day. In this way, the wraps never tasted the same as on the other days. Nevertheless, we were all quite glad that the wrap time was over after two weeks.

Some were always there when vegetables had to be cut, pasta had to be cooked or meat had to be grilled.

Looking back, I can gladly say that we never needed a Snickers. There was only one moment we came very close to that point. If a part of your group is going for an extensive hike, make sure beforehand that they do not have the key of the car where all the food is stored. Or at least, keep the crisps for the afternoon snack separate from the dinner ingredients!

Despite travelling through rather hostile lands, we always ate very good. I would not have expected such a variety of food before the excursion started, rather I prepared myself to a lot of sandwiches.

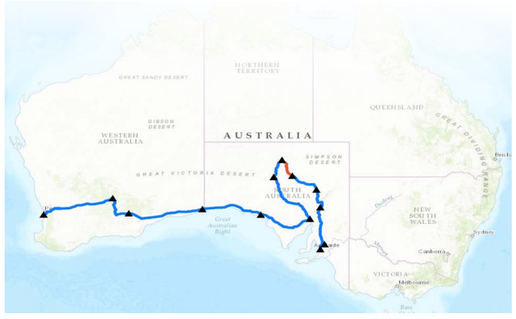
A big THANK YOU goes out to all of us working together to prepare delicious meals on camping stoves and especially to Sandra. In a few months we will even consider wraps as a meal again.

Fig. 134: Luca is in charge of the daily BBQ (Photo J. Sturm)

Fig. 135: Somebody needs to do the dishes afterwards... (Photo A. Hueni)

Fig. 136: A balanced selection of vegetables and meat (Photo M. Kneubühler)

Oodnadatta - William Creek



Day 11, 27 January 2016

Mathias Kneubühler

This day was the day we had been looking forward to! The famous Oodnadatta Track, an unsealed 617 km outback road between Marla and Marree was calling. After a somehow short night for a few of us, we had breakfast in one of our air conditioned cabins. Yes, we stayed in cabins in Oodnadatta because the staff at the Pink Roadhouse was too concerned to let us camp outside due to the normally very high nighttime temperatures in the mid-thirties. However, even that night was surprisingly pleasant if not a bit cool, as most of the previous nights had been, too.

The famous Oodnadatta Track, an unsealed 617 km outback road between Marla and Marree was calling.

Fig. 137: Welcome to Oodnadatta! (Photo M. Kneubühler)

The weather seemed to be slightly different this year. Anyhow, the cabin did a good job in preventing the flies from constantly bothering us right from the early hours of the day on.

All expedition gear was loaded into the four cars by 08:00 and with a tasty cup of coffee in our hands we left the Pink Roadhouse, the last tiny spot of civilization, to head in south-eastern direction on the Oodnadatta Track towards William Creek. Only a few days ago, the track had been closed to all vehicles due to recent flooding caused by heavy mid-summer thunderstorms over the desert. Moisture instantly changes the track into impassable mud and we were happy the road was declared open by the road authorities on this day. Luckily, weather forecasts, although slightly unstable these days, seemed to predict no further rain for the days to come.

The Oodnadatta track follows a traditional Aboriginal trading route through a stunning semi-desert scenery, which was unusually green due to the recent rainfall – a very unexpected situation for our eyes. The track largely follows the famous string of springs, numerous mounds that feed water from the Great Artesian Basin underlying Australia's red centre [1]. Between Marree and Oodnadatta, the Australian Overland Telegraph Line and the historic Old Ghan Railway track run largely in parallel with the track through vast and open land southwest of Lake Eyre, the world's largest internally draining catchment with an area of 1.2 million km^2.

Fig. 138: Algebuckina Bridge of the Great Northern Railway (Photo S. Bertschi)

The dust was ubiquitous on the track and visibility fell to zero whenever our convoy stayed too close together. Our first stop after a one hour of gravel track driving was Algebuckina Bridge of the Old Ghan Railway spanning the Neales River. The adjacent waterhole has never dried up in history. The bridge was opened in 1892 and is the largest single bridge in South Australia.

Fig. 139: Travelling on the Oodnadatta track (Photo J. Sturm)

Back on the Oodnadatta track again, we soon left this gravel path again to continue our journey on what is called a PAR (public access road). Although still known to our GPS navigation devices, a very rough off-road track of 16 km length (one way) awaited us that leads to the Freeling Spring group, a stunning wetland area naturally fed by artesian water at the edges of the Great Artesian Basin. The track was doable, no drama, as long as you let the car negotiate its own way across rocks, wash-outs and erosion channels. In close vicinity of the springs, the ruins of the Old Peake repeater station of the Australian Overland Telegraph Line emerged on the gentle slopes of a hill (28.06° S, 135.91° E).

The 3'200 km long telegraph line that connected Port Augusta in the south to Darwin in the north was completed in 1872 and allowed fast communication between Australia and the rest of the world [2]. Repeater stations, where received Morse code was re-sent, were built every 250 km.

Fig. 140: Ruins of the Old Peake repeater station (Photo D. Fawcett)

Fig. 141: Natural springs of the Freeling Spring group in semi-arid desert (Photo D. Fawcett)

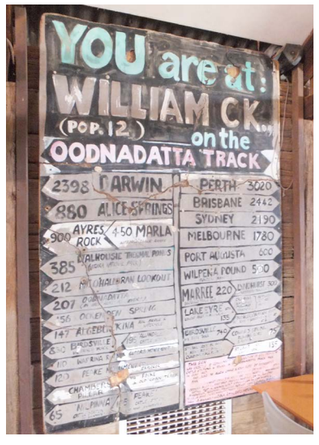


Fig. 142: Signpost at the William Creek Hotel (Photo M. Kneubühler)

Fig. 143: The few buildings of William Creek as seen from nearby sanddunes, illustrating the extreme effects of the Bidirectional Reflectance Distribution Function (BRDF) (Photo A. Hueni)

Almost two hours later, nearly everyone felt relieved when our four cars successfully reached the comfortable gravel of the Oodnadatta track once more. Although quite hungry with the time now well after lunch already, we decided to drive the remaining 130 km into William Creek all in one. There was no shade along the road to stop for lunch, anyway. What a relaxing ride at 80 km/h on that gravel path compared to the previous off-road experience on the public access road! Finally, at around 3 pm, we reached William Creek Hotel. The adjacent campsite would be our overnight resting place, however, we were strongly advised to go for air conditioned cabins again to escape the unbearable heat at night time. Well…

Halligan Bay, the lowest point in Australia at 15.2 m below sea level on the salty shores of Lake Eyre is in the vicinity of William Creek. That's why we decided to go on an evening excursion right after our mid-afternoon lunch at the campsite. Back on the Oodnadatta track for some 10 km, a somehow hidden sign announced the PAR deviating sharply to the north from the track to reach the lake's shore after 65 km of off-road driving. We wanted to see the colonies of flamingoes that were said to be in the area after the recent rainfall. Things, however, worked out differently than anticipated, as can happen easily on an expedition as ours. Our convoy got abruptly stopped by a barrier blocking further access into the area. We returned somehow disappointed to William Creek Hotel where the lady at the bar explained us that access to Halligan Bay was in fact prohibited during the hottest period of the year since a young couple experienced a fatal breakdown of their car in this remote area a few years ago.

Our convoy got abruptly stopped by a barrier blocking further access.

The William Creek pub was definitively *the* place to be while staying out here. The interior is impressively decorated with hundreds of photographs, newspaper stories and all kinds of reminiscences of the area and from around the world. And the beer is really cold.

The outback settlement of William Creek lies roughly half way between Oodnadatta and Marree and essentially consists of the famous hotel and pub, a fuel station and the campsite.

In addition, there is an interesting collection of space debris that were found in the vicinity of the settlement and originate from rockets that were launched from the Woomera Rocket Test Range 250 km south of here [3, 4]. The test range was established in 1946 in the frame of an Anglo-Australian joint weapons design and test programme. The Womeera Prohibited Area in South Australia was home to seven British nuclear tests at Maralinga, causing resettlement and denial of access, as well as death and illness due to contamination to the local aboriginal people.

The outback settlement of William Creek essentially consists of the famous hotel and pub, a fuel station and the campsite.

The largest piece of debris at William Creek is a 1st stage main fuel tank of a British "Black Arrow R3" three stage rocket launched from Womeera in 1971. This rocket placed the British experimental satellite Prospero in orbit [5]. Prospero was the first British satellite successfully launched by a British rocket and remained operational until 1973.

With temperature becoming more comfortable after sunset and the flies slowly becoming less of a nuisance, we eventually joined forces to prepare a couscous dinner in front of our air conditioned cabins.

Fig. 144: The William Creek Hotel, a famous pub in the Australian outback (Photo J. Sturm)

References

[1] Government of South Australia (2016). The Oodnadatta Track – String of Springs Southaustralia.com/~/media/consumer/files/ places to go/flinders ranges and outback/oodnadatta-track-string-of-springs.ashx?la=en-us

[2] Wikipedia (2016). Australian Overland Telegraph Line en.wikipedia.org/wiki/Australian_Overland_Telegraph_Line

[3] Wikipedia (2016). British Nuclear Tests at Maralinga en.wikipedia.org/wiki/British_nuclear_tests_at_Maralinga

[4] Wikipedia (2016). Womeera Test Range. en.wikipedia.org/wiki/Woomera_Test_Range

[5] Wikipedia (2016). Prospero Satellite. en.wikipedia.org/wiki/Prospero_(satellite)

Fig. 145: Debris of the 1st stage main fuel tank of a British "Black Arrow R3" three stage rocket launched from Womeera in 1971 (Photo M. Kneubühler)

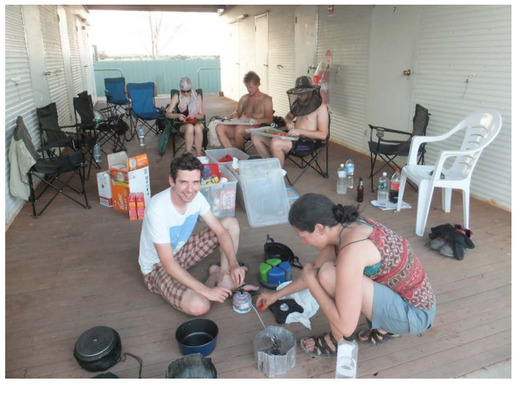


Fig. 146: Preparing group dinner in front of the air conditioned cabins at William Creek (Photo M. Kneubühler)

The Australian Great Artesian Basin

Mathias Kneubühler

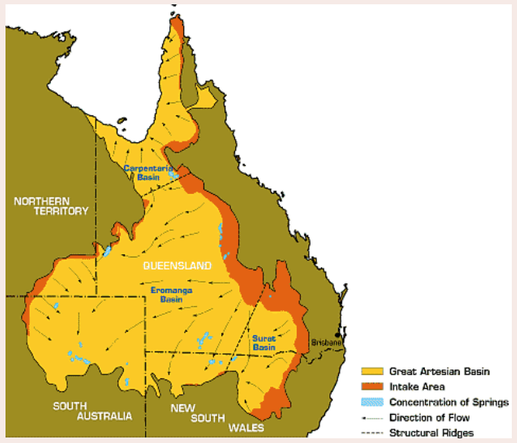


Fig. 147: Location of the Great Artesian Basin [1]

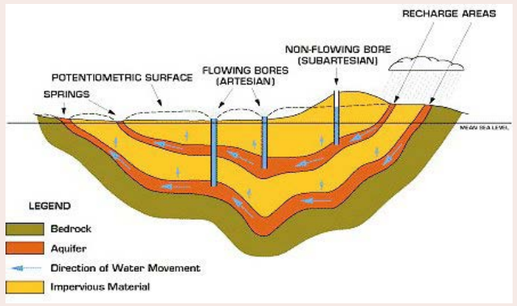


Fig. 148: Profile view of the Great Artesian Basin showing recharge areas in the northeast and springs in the south of the basin [1]

The Great Artesian Basin (GAB) that underlies approximately 1.76 million km^2 of the Australian continent is one of the world's largest groundwater aquifers with an estimated 64'900 million megalitres of water in storage. The basin was formed between 100 and 250 million years ago and underlies 22% of Australia. Water falling as rain on Queensland's Great Dividing Range enters the basin in Australia's east and moves slowly down along porous sandstone layers into South Australia at an average of less than three metres a year. When finally rising from pressurized and hot natural springs and artificial bores in South Australia, the water is around two million years old. More than 1'700 individual springs in 23 complexes can be found within the South Australian part of the GAB [2].

The basin's springs, also known as mounds, have been ecologically important landscape features for around 750'000 years. Indigenous Australians identified the springs as important permanent sources of water thousands of years ago. The string of springs made the exploration of Australia's interior possible with John McDouall Stuart to complete the first continental crossing from south to north in 1862. Since the time of European settlement in the 1870's, the springs have served as a lifeline within the Australian arid zone by supporting a significant farming industry and essentially defining the pathway of the Australian Overland Telegraph Line that linked Australia to the world for the first time. The springs aligned along the southern and western margins of the GAB outlined the route of the Great Northern Railway (Old Ghan Railway) between Farina Station and Oodnadatta in South Australia [2].

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Linking wetland area and ground water flows in the Australian Great Artesian Basin using remote sensing

The sustainability of the springs in the Australian Great Artesian Basin (GAB) is increasingly threatened due to current and projected ground water extractions for mining operations within the region. A recent study by White et al. [1] demonstrates the use of wetland area derived from analysis of high-resolution satellite imagery as an indicator of groundwater flow in the GAB. While previous mapping and monitoring of the discharge and associated wetlands of the GAB springs were based on site-specific and time consuming techniques to estimate spring discharge using aerial photography with metre and bucket and stop-watch measurements of flow rates, the recent study intends to develop a remote monitoring tool of wetland vegetation extent that builds on the relationship between spring discharge rate and wetland vegetation extent with less reliance on site-specific ground-based calibration. The authors investigated their Normalized Difference Vegetation Index (NDVI)-based wetland delineation indicator for remote monitoring of groundwater flows in the Australian GAB in three representative spring wetlands in South Australia: the Dalhousie Spring Complex, the Freeling Spring (Old Peake) Group and the Hermit Hill Spring Group. They found strong positive relationships between spring flow rate and wetland area at the three contrasting sites and conclude that the approach provides natural resource managers with an indicator of spring wetland response to impacts of land use, groundwater extractions and climate change over time for the GAB and potentially other aquifers worldwide.

Reference

[1] White, D.C., Lewis, M.M., Green, G., Gotch, T.B. (2016). A generalizable NDVI-based wetland delineation indictor for remote monitoring of groundwater flows in the Australian Great Artesian Basin. Ecological Indicators, 60, 1309-1320

Fig. 149: View from a vantage point over the wetlands at Freeling Spring Complex with the remains of the Old Peake Overland Telegraph repeater station established in 1871 (Photo D. Fawcett).

William Creek - Farina Station

Day 12, 28 January 2016

Joan Sturm

At 07:00 in the morning the alarm clocks went off in our small cabins. Waking up that morning was suddenly way easier when we took a step outside and saw the morning sky. It was not quite the apocalyptic sky from the previous evening but still a beautiful sight in the morning. The ablution block on the camp site of William Creek had already made us aware the day before that the tap water in the desert is nowhere near the quality of tap water we are used to from Switzerland. Showering and brushing one's teeth is bearable with salty, briny tap water, but salty morning tea… it was absolutely disgusting. We had to redo it with bottled water just to wash away the taste of it.

Due to the tea incident, and only because of this, not because of anything else, we were a bit late to leave William Creek. Normally, we topped up the fuel tanks every morning as the distances in Australia soon teach you to take every opportunity you get to fill the tank. Not this morning. It was just too expensive, they charged 2$ a litre, and our tanks were not that empty yet. Cross fingers that we make it until Marree.

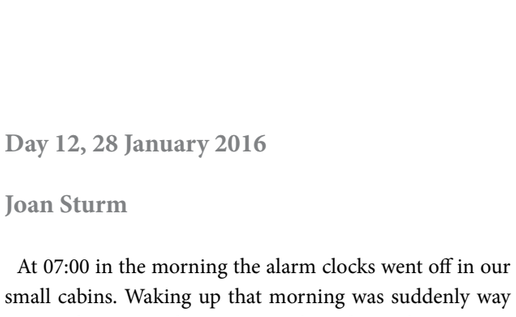

Fig. 150: A dingo in Australia's desert (Photo F. Maag)

We had not come very far when Andy, driving the first car that day, suddenly stopped. The reason was soon clear as we saw four dingos crossing the road. They might have been as surprised to see us as we have been to see them. Dingos roam Australia freely north of the dog fence, which

was installed to keep the dingos away from the sheep farms. Whether it was their sheep-less diet or the harsh circumstances in the desert, they looked extremely thin and we could easily count all their ribs. But there is no need for concern for all animal lovers as we were ensured that dingos always look super thin.

Soon after our dingo encounter we took a turn-off towards the Strangways Springs. It is one of many clusters of mound springs along the Oodnadatta track, which provide a permanent source of water in an otherwise arid environment. It is no wonder that the Old Ghan and the Overland Telegraph line ran along these springs. Mound springs occur where underground waters of the Great Artesian Basin come to the surface.

Fig. 151: One of the most venomous snakes in a mound spring (Photo S. Roth)

Aquifers consisting of sandstone transport the water from the eastern part of Australia towards the centre. In fracture zones such as along the Oodnadatta track the water nears the surface and during its ascent it collects sediments and dissolved mineral salts which are responsible for the typical mounds. The mounds are the accumulated sediments and continue to grow higher and higher as long as the water pressure is strong enough. For approximately one hour we walked around the springs, accompanied by flies who seemed very eager to tell us about their day, therefore landing on every available spot on our bodies. Most

Fig. 152: A mound spring at Strangways Springs (Photo D. Fawcett)

of the springs around Strangways have stopped flowing, a process which has been hastened by the dropping of the ground water level. Nevertheless, two of the springs were still active water sources and one even bore an inhabitant we were not eager to see a second time; at least all of us with a surviving instinct that somehow seemed to have left Daniel, or he might have never had one in first place, as some camp fire stories revealed. When reaching the top of a mound we spotted a brown snake insinuating itself across the pond's surface, notably one of the world's most venomous snakes.

Most of the springs around Strangways have stopped flowing, a process which has been hastened by the sinking of the ground water level.

Before lunch we turned off a third time for another set of springs, the Wabma Kadabu Mound Springs. The aboriginal people have stories about each of these places. The tale of Wabma Kadabu tells the story of a hunter who looked for the stranger snake. He found its tunnel and at last the snake itself and killed it. The fight of the hunter and the snake can be seen in the water's movement (in the Bubbler spring). The hunter cooked the snake for his dinner in a ground oven (Blanche Cup – another spring) and threw the head away, which now is represented in the landscape by Hamilton Hill.

Fig. 153: Spa at Coward Springs (Photo J. Sturm)

Fig. 154: Has anybody yet mentioned how nerve wrecking the flies in Australia's centre are? They are an absolute pain in the neck! (Photo J. Sturm)

Fig. 155: Where the salt crust still held our weight (Photo J. Sturm)

Further along the track we turned off for the Coward springs where the water from one of the springs was channelled into a small little spa. A few of us took the chance to cool down a bit and refresh in the pool. The others went searching for dates. They even found them and with some long sticks and tiptoeing a few could be plucked.

At midday we passed Lake Eyre South, which lies 12 metres under sea level. We stopped to take a look at the vast salt plain. As all of us were hungry we decided to have lunch. You might have already guessed what our meal was. No? We had wraps! Packed under a small shelter with information boards, the only shade within miles, we ate our meal.

After the lunch break we decided to take a stroll down to the lake and test if the salt crust would carry us. It did. At least in the beginning… the further in we went the more difficult it became. Our feet started to sink in. Things got worse when a sneaker had to be dug out of the salty mud in which it decided to take a rest after the leg was pulled out without the sneaker on it anymore. That was not the only way the Salt Lake tried to attack us. In a sneaking pact with the wind it stole Tobi's hat. All the running after it and the full-on effort to save it was only rewarded with a thicker salt/mud crust on Daniel's lower body half. The hat continued its path along the lake surface, whirrling along like a tumbling weed.

Fig. 156: Salt and mud covered over the ankles (Photo S. Bertschi)

On our drive after the lunchbreak we passed the Mutonia Sculpture Park where former mechanic Robin Cooke

Fig. 157: Mutonia Sculpture Park (Photo J. Sturm)

designed sculptures of recycled metals, and collected useless waste products that have been found in the Australian centre.

In Marree, the only settlement we would pass through today with a stunning amount of 70 inhabitants, we topped up the fuel tanks and treated ourselves to an ice cream. We also discovered that the crack in Christoph's windscreen from the morning had been growing continously.

Shortly before five o'clock we arrived at Farina Station after 260 kilometres on gravel road and were greeted by two emus strolling over the campground. It is a nice campground with a grass floor and some trees for shade. We set up our camp and played some rounds of Tennis or Yatzee while enjoying a cool beer. Sandra proved once more that she is as good as gold when she offered to clean the salt and mud crusted shoes. A Bundaberg ginger ale and ice cream the following days were needed to at least lessen our guilty conscience.

For dinner delicious pasta with tomato sauce was prepared by half of the group. The other half, led by Daniel did the dishes afterwards. Those who were lucky enough to not being on kitchen duty made themselves comfortable on the camping chairs or took their mats out of the tents and lay on the ground waiting for the milky way to fully appear and sparkle in all its beauty.

… waiting for the milky way to fully appear and sparkle in all its beauty.

We watched the stars, with every time we go better in spotting the Southern Cross and secretly made our wishes when a shooting star crossed the sky. Fortunately, the night sky in the desert is so bright that we saw more than just one and everyone got the chance to make a wish. The rise of the moon was spectacular. It was not full and with Andy's binocular one could easily see the craters at the edge, half illuminated and half in the shadow.

Fig. 158: The soft evening light falling on our camp (Photo C. Rohner)

Fig. 159: First impression of our most deserted and absolutely perfect campground at Farina Station (Photo C. Rohner)

Fig. 160: Lots of little frogs (Brown Tree Frogs) peacefully went to the toilet with you and accompanied you while brushing teeth (Photo A. Hueni)

Aborigines

Tobias Klee

History

The term “Aborigines” is not describing one people, but hundreds of different tribes with different languages. Aborigines means simply indigenous people. Between 40’000 to 60’000 years ago, the first Aborigines populated Australia, coming over a land bridge from New Guinea.

The population size at this time is estimated between 300’000 and a million inhabitants. With the arrival of the first Europeans, the number of Aborigines was reducing dramatically. The population shrunk to only 5-20 % of what it used to be, with a minimum of 60’000 people in 1920. The reasons for that were mainly conflicts and diseases brought by the Europeans. Today, almost half a million Aborigines are living in Australia [1].

Traditional way of living

Aborigines do not have a religion with a god. What comes closest to a religion is the “dreamtime”, which is the term for the aboriginal mythology. The dreamtime is a time- and spaceless source of existence. The origin of everything that lives is in the dreamtime. The mythology is godless; the dreamtime is manifested in the nature. Landmarks tell stories and show happenings of the dreamtime. Figures of the creation story form the lands, so a rock may be a dog or another figure of dreamtime legends. An important creature is the rainbow serpent, being oogamous. The female appearance created the scenery and especially waterholes, the male appearance is the sun and when the serpent is moving from one waterhole to another, the rainbow is seen. There are also myths which say that the didgeridoo is representing the vibrations the rainbow serpent made while creating the scenery.

The stories and myths of the dreamtime are retold from generation to generation, sometimes also in songs. The stories and the songs built a map that served as a base for walkabouts and orientation.

As European settlers settled in places with water supply, they destroyed lots of the mystical places around waterholes. Forests were deforested and ancient lands converted to agricultural areas. Places with water were occupied by the settlers. Newly introduced animals like cats, dogs, horses and sheep led also to a change in the flora and fauna. Aboriginal people got allocated into reservations. Traditional hunting-gathering was not really possible anymore. People were dependent on food supply of the Australian government. More and more children with a white father and an aboriginal mother were born, which led the government to its assimilation politics.

Nowadays, Aborigines are working on farms, as tourist guides or selling handcrafts. Attempts to go back to traditional living only have little success. Two thirds of the Aborigines are living in cities [2].

Politics of the Australian government

Due to the assimilation politics of the Australian state between 1870 and 1970, aboriginal children were taken away from their families in order to educate them like whites. Between 10-30% of the children were affected, mostly the half-caste children. The idea behind such politics was, that after four generations of white education, no aboriginal gene should be left. In 1997, the National Sorry Day was established, but the first time a prime minister officially apologized was not until 2008.

When James Cook arrived in the 18th century and the colonization of Australia began, he declared Australia as Terra Nullis, which meant that all the land was free to claim, including the lands of Aborigines. Starting in the 1960’s, some lands were given back to the Aborigines. The rights for Aborigines are officially written down in the Australian Constitution. The so-called Racial Discrimination Act (1975) is standing above the legislation of the federal states, and is in short summary prohibiting racial discrimination [3].

In the beginning of the Australian State, Aborigines had the right to vote like British citizens. Around 1900 however, new laws denied them to vote. Finally, in the sixties Aborigines were allowed to vote again. But even though they have the same rights like the citizens of the Commonwealth [4], there are still inequalities between whites and Aborigines. The amount of people without work is at 20%. The life expectancy of Aborigines is ten years lower than the whites’ [5]. Child mortality is twice as high for Aborigines.

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Fig. 161: Australia’s Lake Eyre drainage basin covers 1.2 million square kilometres, almost one-sixth of the continent, and stretches from Northern Territory to South Australia. Lake Eyre does not always hold water. Occasional rainfall drains through Queensland’s Channel Country and the Simpson Desert basin into Lake Eyre, which has no outlet. Lake Eyre is the fifth largest terminal lake in the world. The southwestern lobe of the lake is the deepest portion at 1.4 metres. The Landsat 5 Thematic Mapper (TM) image was captured on 10 June 2009 at maximum water level. Large parts of Lake Eyre were again filled with water after heavy rainfall in January 2016 [1]. (Source: NASA Earth Observatory, earthobservatory.nasa.gov/IOTD/view.php?id=38994. [1] BBC News (2016). bbc.com/news/world-australia-35203730)

Farina Station - Flinders Ranges

Day 13, 29 January 2016

Sonja Bertschi

Fig. 162: Sunrise at Farina Station (Photo S. Bertschi)

The faint morning light announced another great excursion day – and another impressive sunrise. There was no noise at all, except of some twittering birds. What a quiet place!

And at that very moment the first rays of sunlight added a surreal reddish colour over the whole scenery.

Still before sunrise, after a very early first glimpse out of the tent I quickly grabbed my camera and walked out into the empty landscape surrounding our remote campground. It was after only a few steps up the little elevation beside the camp when I got startled by a few loud stamps: Kangaroos bounced around in a distance of a few metres only. And at that very moment the first rays of sunlight added a surreal reddish colour over the whole scenery.

The campsite at Farina Station was the most secluded of our journey: besides the handful of our tents, the four dusty, would-be 4WD cars and a very basic camp infrastructure, the open sky, the old gum trees and the animals made it a perfect spot. But our plan for the day was to drive further south into the area of the geologically ancient Flinders Ranges, where we hoped to arrive early enough for a scenic walk in the famous Wilpena Pound area.

After our daily morning routine and another delicious breakfast with hot coffee, tea and Joan's meanwhile famous scrambled eggs, we started to drive back to the sealed Outback Highway and headed south, with the plan to stop at Leigh Creek to stock up on our food supplies. Leigh Creek (about 500 habitants) was formed by the South Australian Government in 1982 to support a coal mine. We arrived there shortly before the shop opened – and had a first impression of a sleepy outback town where nothing seemed to happen. Latest news actually announce that "The whole township of Leigh Creek is for sale." The "reason why" lies in the closure of the coal mine.

Fig. 163: Off-road driving, Parachilna Gorge (Photo S. Bertschi)

During the next driving hours the sky became overcast. At Parachilna, another small country town, we left the Outback Highway and chose the unsealed road eastward into the Flinders Ranges through Parachilna Gorge towards Blinman. This scenic drive snakes through the Heysen Ranges and the ABC Ranges where spectacular rock formations, old river red gum trees and rock wallabies caught our attention.

Blinman was another seemingly deserted little (copper) mining town where we stopped for a short break. From there we headed again south for another driving hour, towards our campground at Wilpena. We stopped at more scenic lookouts to admire the timeless landscape and the crests of the Wilpena Pound formation.

We arrived at this ample camping area by early afternoon

Fig. 165: On the walking trail along Wilpena creek, near the Hill's Homestead (Photo S. Tjin)

where most of us set up their tents on the stony ground, among beautiful gum trees. After a short lunch we prepared for a walk to Hill's Homestead, Sacred Canyon and the elevated Wangara Lookout.

A few of us then decided to walk even further and were rewarded by spectacular views of the pound with its changing vegetation on higher areas. After the steep climb down from Tanderra Saddle, we were running quite late for dinner and quickened our steps, despite feeling somewhat tired after several hiking hours. However, the evening hours were the best time to spot wildlife.

Luckily, the hungry hikers were back just in time to set up the remaining tents – only minutes before it started to rain at nightfall. Everybody very much appreciated the tasty dinner prepared by the group earlier that evening.

Fig. 164: The Central Flinders Ranges from a lookout on the Outback Highway (Photo S. Bertschi)

Fig. 166: View from the Wangara Lookout over the surprisingly dense vegetation in the southern part of Wilpena Pound (Photo S. Bertschi)

Geology in South Australia: The Flinders Ranges

Sonja Bertschi

Recognized as one of Australia's oldest natural landscapes, the rugged peaks and tranquil bush scenery of the Flinders Ranges stretch over a distance of over 400 km, from 300 km north of Adelaide northward. The ranges extend in a series of north-south trending strike ridges, intersected by many gorges. The elevation of almost all of the ranges is above 300 m. Locally, peak elevations exceed 1000 m. Surrounding the Flinders Ranges are low-elevation, low-relief regions that are dominated by playa lake systems that drain internally (as Lake Eyre) and granitic inselbergs (such as Pildappa Rock). On the Australian continent, the Flinders Ranges form one of the most seismically active regions at present, with hundreds of small earthquakes being recorded every year [1, 2].

Geological history

The formation of the Flinders Ranges began about 850 million years ago. An ancient shallow sea, which covered the area for about 350 million years deposited different sediments to the area, which was the passive margin of the ancient continent of Rodinia. About 600 million years ago, while Australia and Antarctica were still a single continent, the seafloor along their east coast began to plunge beneath them. The mountain chain was pushed up by this orogeny where the geosynclinal sequence was folded and faulted into a large mountain chain. This chain exists nowadays in two parts, the Transantarctic Mountains in Antarctica and the Flinders Ranges in Australia.

The original ranges had been eroded and reduced almost to the level of the surrounding plains. Minor earth movements rejuvenated the area, thrusting the area up into a vast plateau that has since had the softer rocks eroded away to leave the harder rocks such as quartz as folded ridges of the present ranges. Today, the rocks of the Ranges are mostly quartzites, limestones, shales and sandstones.

The Ranges' most famous landmark is Wilpena Pound, a rock basin of roughly 100 km^2 within the Flinders National Park. Its synclinal structure today forms a level ground surrounded by rising slopes and looks like an amphitheatre. The outer ring of cliffs rises about 500 m from the plains with St. Mary's Peak, the highest peak not only of this formation but also of the Flinders Ranges. It reaches about 1170 m above sea level [1, 2, 3].

Flora and fauna

The flora of the Flinders Ranges consists of plants adapted to a semi-arid environment. Trees like cypress pine and black oak are very common for this area. In more moist areas near Wilpena Pound, plants like grevilleas, lilies and ferns can be found. Water-loving reeds and sedges grow near springs and waterholes. Red kangaroos, western grey kangaroos, echidnas and wallabies are the most common animals of the Flinders Ranges area. More than 100 native bird species live in the area, like parrots, galahs, emus or the wedge-tailed eagle. Reptiles include goannas, snakes, bearded dragon lizards, skinks and geckos [3].

Ediacaran fossils

The Ediacara Hills in the northern Flinders Ranges were the site of discovery of some of the oldest fossil evidence of animal life. Some exposures of rocks span from around 2'000 - 500 million years ago and have preserved a record of the emergence of life on Earth. Recently, the new geological period, the Ediacaran Period, was formed and named after this site [1].

The Flinders Ranges today

Cave paintings, rock engravings and other artefacts indicate that Aboriginal people have lived in the Flinders Ranges for thousands of years. During the late 1870s, agriculture and mining were the main industries of the area. Apparently, the Flinders mountain range area experienced unusually good rainfall and crops around that time. This, along with the copper mining induced (persuaded) the government to build a railway line north of Port Augusta. Later, the rainfall returned to a normal pattern for the region, causing many of the agricultural farms to collapse. Today, the climate of the region is semi-arid with hot dry summers and cool winters. The area gets as little as 250 mm of rain annually, most of it during the winter months [2, 3].

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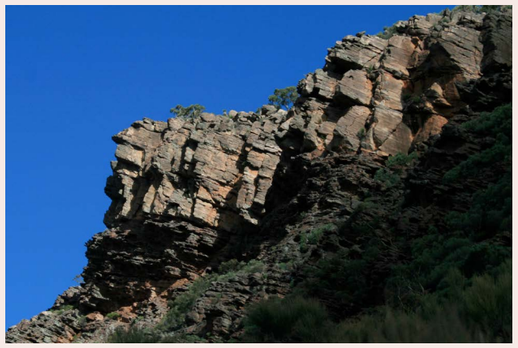

Fig. 167: Quartzite rock formation around Wilpena Pound (Photo A. Hueni)

Fig. 168: Spectacular view from above Taddera Saddle in direction north (Photo A. Hueni)

Fig. 169: Sturt's Desert Pea, the floral emblem of South Australia (Photo S. Bertschi)

Fig. 170: Grasstree in the Flinders Ranges (Photo S. Bertschi)

Fig. 171: Bottlebrush (Photo A. Hueni)

Australian plants

Lola Suarez

Australian native vegetation is the result of evolution in geographical isolation, leading to 85% of the existing species being endemic. This very unique floristic compositions cannot be found elsewhere. Australians are proud of their native vegetation richness; species counts reach almost 30'000 including trees, shrubs and herbaceous species, and are custodians of such rich natural heritage. Plants are an intrinsic part of the nation's history as a source of construction materials, food and medicines. The attachment to their flora is present in aboriginal art, in literature and is part of the national identity. As an example, the yellow colour of the "yellow wattle" is a typical Australian colour and each state has a floral emblem.

One could say that with 80% of forested areas being covered by eucalypts, Australia's woody coverage is homogeneous. That person, however, would probably not know about the existence of almost 900 eucalypt species. Each species has adapted to a specific cohort of environmental and geomorphological conditions. Eucalypt trees are found reaching from 4-8 metres height in drier and less dense woodlands to as tall as 80 metres in rainforest (mainly present along the SE coast), where "mountain ash", the tallest flowering tree species, can be found. Eucalypts typically grow their canopies in clumps of branches and leaves oriented vertically. This structure allows more light to reach intermediate canopies and understorey and reduces the exposure to sun, therefore the evaporative demand on hot days.

The "river red gum" (E. camaldulensis) is one the most important species that has a strong connection to the country's history. Its specimens can live up to 500-1000 years, being considered sacred for many communities. Its wood was used by aboriginal communities to build canoes, as it is evident in still visible scars of very old specimens. River red gums grow along river beds and in areas where water is available seasonally. They are tenacious "survivors", able to survive prolonged dry periods between wet seasons. The vegetation growing in dry areas is highly opportunistic, little rain is needed to get a green cover in the desert and there are numerous species that are adapted to highly saline environments. All these ecosystems are essential to maintain the habitat of the fauna and the soil structure in those areas subject to extreme weather conditions.

Fig. 172: Tree canopy in Southwestern Australia (Photo A. Hueni)

Fig. 173: Gum trees at the Hookey's Water Hole (Photo M. Kneubühler)

Fig. 174: Gum tree showing the typical clumping of the canopy (Photo J. Sturm)

Fig. 175: Wilpena Pound is a natural amphitheatre of mountains in the heart of the Flinders Ranges National Park. The area is part of a huge syncline with a range of mountains both on the western and eastern edge of the Pound, joined by the Rawnsley's Bluff at the south. The gently sloping mountain walls almost completely encircle the interior of the Pound, dominated by St Mary Peak (1171 m) on the north-eastern side and the gorge at Wilpena Gap further to the east. The sediments in the rift complex date back 870-500 million years to a time during the breakup of the supercontinent Rodinia. The Enhanced Thematic Mapper Plus (ETM+) on the NASA/USGS Landsat 7 satellite captured this natural-colour image on 07 March 2003. (Source: NASA Earth Observatory, earthobservatory.nasa.gov/IOTD/view.php?id=43971)

Flinders Ranges - Tanunda

Day 14, 30 January 2016

Luca Scherrer

Getting up that day was certainly not as easy as on the days before. With temperatures below 10° Celsius and a wet mist, we felt like being in Scotland or a place similar to that. This feeling was also endorsed by our famous sailorman, wearing a down jacket and, most importantly, a beanie with a Scottish flag on it. The rest of us, mostly not equipped with the same amount of winter clothes, tried our best to keep ourselves warm with coffee and/or some hot tea.

Fig. 176: : Sailorman Andy with winter clothes and desperate students trying to get warm (Photo M. Kneubühler)

After packing up all our stuff, including the wet tents, we set off towards south and our last stop in the famous wine region of Barossa, Tanunda. The first part of our journey led us through the southern part of the Flinders Ranges. Shortly after our start, a mob of kangaroos crossed our path and obstructed the street. Thankfully, no animal was harmed and the trip was continued.

Shortly after our start, a mob of kangaroos crossed our path and obstructed the street.

Leaving the Flinders Ranges at the town of Hawker, the scenery got more and more agricultural and again, relatively unpopulated. Along the way, various animals could be seen, whereas most of them cannot be considered as wild anymore. One of our encounters could have ended badly but our driver was able to break hard and therefore not to drive over an emu.

Fig. 177: Amazingly many kangaroos and rock wallabies hopping around on and near the road in the morning light (Photo J. Sturm)

Another encounter on the other hand was very special as well, but due to another reason: next to one of the non-busy roads, a herd of semi-wild horses, known colloquially as brumbies, was chased by men on motorcycles. A spectacle that, most likely, none of our group had seen before.

The landscape we drove through got more and more green, the farther south we got. The fields changed from being predominantly harvested crops (brownish) to vine,

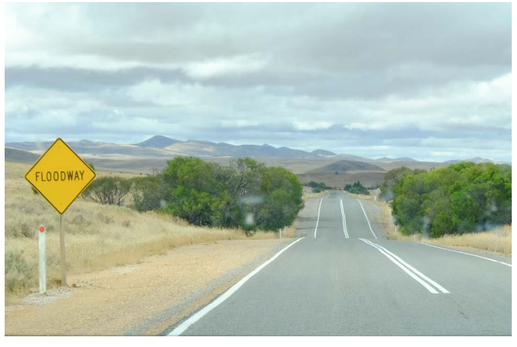

Fig. 178: Driving on this cloudy morning through the southern Flinders Ranges (Photo S. Bertschi)

which was one of the main reasons we chose Tanunda in the famous Barossa Valley to be our last stop before Adelaide. More about South Australia's wine regions (Clare Valley, Barossa Valley, McLaren Vale, etc.) can be found in the corresponding info box.

Thankfully, the weather cleared up by the time we arrived at the Barossa Valley. From a hill on the edge of the valley, we were presented with beautiful views all over the wine region. When arriving at our last campsite, we decided to split up into two groups with one group staying at the campsite and the other one (Joan, Sondra, Fabienne, Dani, Dominic and Luca) heading for a walk into town and a subsequent wine tasting.

Since we had some contact before with one of the wineries, the Chateau Tanunda, we decided to visit the estate with its special buildings. The Barossa Valley is both famous for red and white wines, which grow on very diverse terroirs. Chateau Tanunda takes advantage of that and produces the same types of wines on different terroir. We got an introduction to these special conditions and tried different wines afterwards.

Travis referred about the special situation of the Oodnadatta springs and the latest findings of their research about them.

After a short stroll through the beautiful small town of Tanunda, we headed back towards the Barossa Valley Brewery where we met up with the others for dinner. Our formerly

Fig. 180: Relatively flat and dry agricultural landscape north of the Barossa wine region (Photo M. Kneubühler)

indisposed springs expert, Travis Gotch, was now able to join us for the evening as well. After sampling some local beers we went on to having burgers or pizzas, before we went inside to listen to a talk given by Travis. Travis referred about the special situation of the Oodnadatta string of springs and the latest findings of their research about them. We were made aware of various facts that we had not realized when visiting the springs a few days ago. It was clear to all of us that Travis would have made our trip along the Oodnadatta track even more impressive and memorable.

Fig. 179: Semi-wild horses being herded by men on motorcycles on a field north of Orroroo (Photo J. Sturm)

Fig. 181: Pub talk by Travis Gotch about the visited springs along the Oodnadatta track (Photo M. Kneubühler)

Fig. 183: Scenic drive between Blinman and the entrance to Flinders Ranges National Park (Photo J. Sturm)

Wine growing culture in Australia

Luca Scherrer

Australia has become one of the biggest producers of wine worldwide in the last decades. Due to its size and the associated variety of different climates, Australia has various wine regions distributed all over the country, each with its own specialties and favoured wines that take advantage of the given terroir. Although vineyards exist in all states, it is mainly the regions in the south, mainly in Western Australia, South Australia and Victoria, which are most famous [1]. Although these regions are not the biggest producers, Margaret River (WA), Barossa Valley, McLaren Vale, Clare Valley (all SA) and Yarra Valley (VIC) are the best known and most popular wine regions from a European point of view.

The wine regions of Australia, especially the Clare Valley and Barossa Valley visited on this trip, were and still are under a strong influence of the culture of the respective immigrants. In case of the Barossa Valley, this is particularly evident from German place names such as Krondorf, Hoffnungsthal and Seppeltsfield. In Tanunda, the heartland of the German culture in the Barossa Valley, people sometimes still speak Barossa German [3], a hybrid language that evolved due to the linguistic isolation of the German speaking community.

The Barossa Valley is most famous for its production of Shiraz, due to its hot continental climate and the given terroir [4]. The hot climate leads to a relatively fast ripening of the grapes, which contain high levels of sugar and low levels of acids. Besides the Shiraz, also other red vines such as Mourvedre, Grenache and Cabernet Sauvignon, as well as white wines such as Riesling, Chardonnay and Semillon are being cultivated.

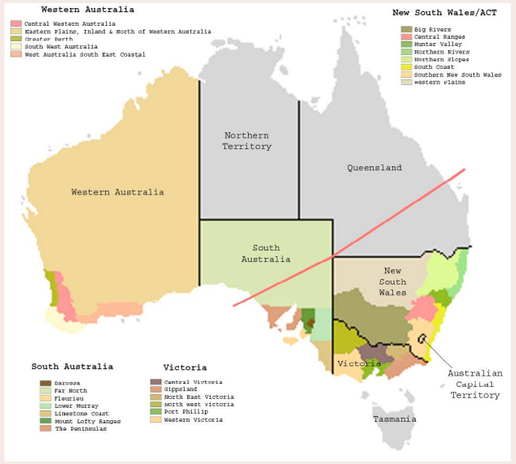

Fig. 182: The various wine regions of Australia [2]

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Fig. 184: View towards the famous Barossa Valley (Photo J. Sturm)

Fig. 185: Wooden oak barrels at Chateau Tanunda (Photo J. Sturm)

Fig. 186: The wine tasting group in front of the Chateau Tanunda (Photo J. Sturm)

Fig. 187: Wine tasting at Chateau Tanunda (Photo D. Fawcett)

End of excursion and farewell: Tanunda - Adelaide

Day 15, 31 January 2016

Mathias Kneubühler

Our last excursion day started like most of the previous days: many of us woke up early, either due to a combination of low morning temperatures and insufficient or non existing sleeping bags, or due to flocks of cockatoos deafeningly screeching in the trees above our wet tents. We had a rich breakfast as every morning and everybody exactly knew his or her duties by now, either when preparing breakfast or doing the dishes afterwards.

However, a somehow depressed mood began to come over most of us since we all knew that the excursion would come to its end in only a few hours time from now. Most of the remaining food (although we calculated very well!) and some cooking gear and group material needed to be distributed before we loaded our four cars for a last time. This time, every backpack had to be packed in a way to allow individual onward travels, again. "Don't leave anything personal in the car" was the motto of this morning. Many of us would be continuing their journey through Australia for another week or two on their own or in small groups and were therefore happy to take over some of the food and camping material, which was now at disposal.

The evening before, we agreed with Travis to meet for a joint farewell coffee at his favourite place in nearby Williamstown, the Bar 41 Artisan Café, at around 10:30 am. This was a short 15 minutes drive from Tanunda, but it certainly was the most quiet drive during our more than 5'000 km excursion in the past two weeks. Everybody was probably going through their numerous memories of adventures and impressions that we experienced as a team and was now trying to cope with the situation that one would very shortly have to organize one's own arrangements again.

Travis and Davina joined us at the Café for a pleasant chat and shortly after, the 2016 Australia excursion officially came to an end in a way we were now all very familiar with: our famous gathering together in a circle – the most effective way of communication in a group, at least in our case.

By noon, our convoy started its last drive through rolling hills of gum trees towards the centre of Adelaide. The rectangular pattern of this neat city, combined with the quietness of a summer Sunday afternoon made it easy to find the couple of hostels where more and more of us left the group.

We are grateful everything went well and everybody is enthusiastic about what we have been privileged to experience and learn, and how harmoniously we have travelled as a group in those past two weeks.

Fig. 188: Farewell from Travis at his favorite coffee bar on Sunday morning (Photo M. Kneubühler)

Fig. 189: The official end of a unique and unforgettable excursion (Photo M. Kneubühler)

Epilogue
Incompetence and bewilderment at Hertz

Andy Hueni

This is a story about bewilderment and poor business knowledge in the rental car line of work when trying to rent four 4WD cars for this expedition. The reader will of course know, or maybe not, in this half educated age, that by 4WD we do mean a car that not only has four wheels but also power transmission to all of them!

We had to book the cars via Hertz International and specifically requested 4WD, for the reason of tackling the rough road conditions around Oodnadatta and William Creek. They stated in an email that they had understood our particular requirements and confirmed that all wheel drive was to be the deal. In fact, we expected to get the Toyota Kluger; a silly name for a vehicle, but there you have it.

Arriving at Perth International we proceeded swiftly to the counter and were surprised to find that we were being issued with a Nissan Pathfinder. A fine car for sure, but not the vehicle we had ordered, and to our knowledge not an off-roader. Voicing our doubts to the assistant made us look somewhat silly:

"Course they are four wheel drive!", the girl behind the desk told us with conviction. We looked doubtful; by her looks the farthest she might have ventured from Perth City was probably the airport where she conducted a pleasant but incompetent business.

Anyway, we were told that they would try to get Klugers on Saturday. Try? Yes, that's right. They would have to see what rental cars were returned on the day and being washed; only then would they know what they could offer. Well, we were nonplussed, I mean to say, what a resource management system have these companies got, not knowing what is being returned where and when?!?

Spatio-temporal asset awareness ringing a bell here?

The assistant also told us in a mollifying way that she would advise the washing service to let her know if a Kluger should get into the shop by today or tomorrow.

Yeah, right, believe it when you see it! Of course nothing of the sort happened.

A sign of four wheel capability was conspicuously absent when we inspected the car: no switches, indicators or stickers made it evident that it was, neither did the handbook give any clue at first sight.

During a little pre-excursion south of Perth we got the feeling that the car drifted at the rear.

Back in Perth we again payed a visit to the car rental. This time two different girls were manning [sic] the desk. Once more, we later on assessed that looks aren't everything, and they were quite pretty indeed ...

We informed them in fullest of our issues, and they claimed that the Kluger and Pathfinder were in the same category and produced a leaflet that apparently showed it. Only strange thing was that our rental papers showed a 2WD in some of the many fields of this form.

One of the ladies informed us very competently: "Well, this car is not to be taken off-road anyway, it's all in the conditions! Nobody reads them of course ...", her voice trailing off.

'Yeah, yeah, you see, we actually did read them and we need that four wheel drive for those gravel roads up near Oodnadatta!'

Our reply prompted her to change tack: "Ah, we put 2WD on the form, just so people don't take them off-road".

'But, still, you say this is all wheel drive?'

"Look here, ", one of them said, snatching a piece of paper from her desk, "on this rental here for a Pathfinder it says all wheel drive!"

Indeed, it stated AWD.

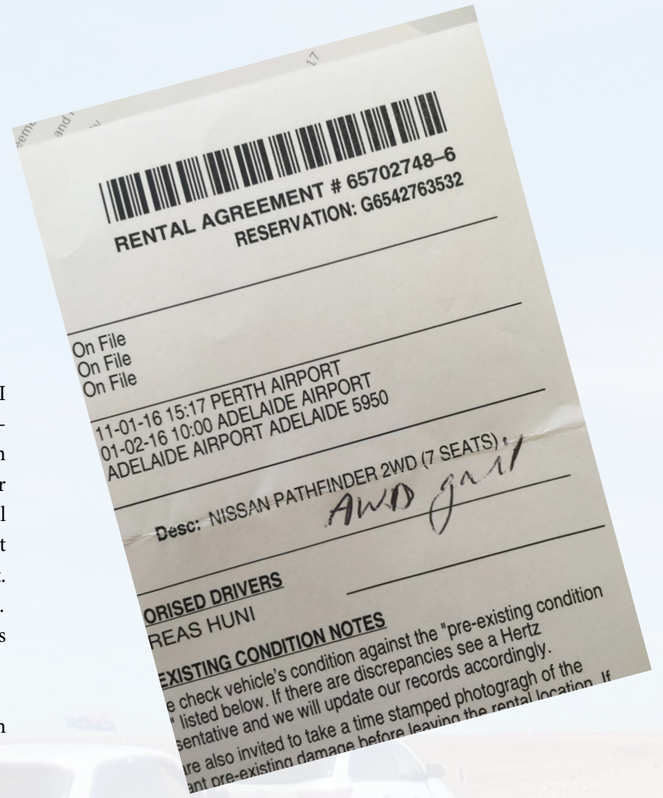
"Our system just prints something, but they are all four wheel drive! 'Cause they are in the same class!"

'Well, sure, that would make sense ...', we conceded, 'but are you sure they are really four wheel drive?'

"I'm just calling the technical guys, ", and she picked up a phone, " ... yeah, that's right, mhm, yeah....", and putting the receiver down: "Yes, it is four wheel drive!"

'Would you mind signing on this paper that it is a four wheel drive?', asked Mathias.

"Sure, no worries...!', she beamd and made an awful scribble that meant to read 'AWD Gail'


RENTAL AGREEMENT # 65702748–6
RESERVATION: G6542763532
On File
On File
On File
11-01-16 15:17 PERTH AIRPORT
01-02-16 10:00 ADELAIDE AIRPORT
ADELAIDE AIRPORT ADELAIDE 5950
Desc: NISSAN PATHFINDER 2WD (7 SEATS)
AWD Gail
ORISED DRIVERS
REAS HUNI
EXISTING CONDITION NOTES
e check vehicle's condition against the "pre-existing condition
" listed below. If there are discrepancies see a Hertz
sentative and we will update our records accordingly.
re also invited to take a time stamped photograph of the
nt pre-existing damage before leaving the rental location. If

Ah, well, what can you do ... back at the campground I did an online check and found that the Pathfinder is regularly featuring front wheel drive, and AWD only upon special order. I then looked under the car and saw no rear transmission whatsoever. While perusing the car manual (page 5-35), Mathias found the switch and indicators that would be mounted if it were fitted with AWD. It was not. We washed down these experiences with a couple of beers.

Turns out these people don't even know what kind of cars they got!

One day later we were back once more, with Gail being in charge again.

"Hello again!", she said by way of greeting.

'Yeah, we did our homework: our car is no four wheel drive, we checked the manual, here, and crawled under the car, there is no transmission whatsoever for that rear axle!"

This time we were not challenged, but handed an envelop and sent to see Joe, the technician.

'G'day mate, how's it goin'? We're here to get a four wheel drive car!', I said, and he immediately warmed up to us.

I told him the story about the four wheel drive issues and he said :"No worries, well, sort it out!". The car we ended up with was a Kluger! Awesome! It even said AWD at the back!

'You know, the girls told us that all Pathfinders were 4WD!', I told Joe.

"Yeah, they think they know it all, but they know nothing, they just look good!", he said in beautiful Ozzy slang.

'That's what we reckoned, mate!', I chuckled.

Just occasionally it does one good to see one's right!

Saturday arrived and so did we at the Hertz office, once again, but hopefully for the last time. We were lucky to get one Kluger, but then the same old story unfolded again of not having 4WD, of not being allowed off the road anyway, but now enriched with the statement that the Kluger had no 4WD.

I personally followed one of the office staff into the car park, just to tell him:'That is not a 4WD!', when being presented with yet another standard Pathfinder.

Dani Henke had some words with the manager who took it rather stoically and seemed unmoved by an outbreak of Bavarian temperament.

We even started to ask at other rental companies for 4WD, but then, miraculously when Mathias entered the office once more, the manager told him:"Ah! It's Klugers that you want! We got many of those!"

They apparently found one in another car park, still dirty, as we gathered from the radio communication that was going on.

Evidently they did only find one Kluger, but proceeded to produce a Pathfinder with AWD. We were intrigued by these going-ons that escaped any rational explanation.

This morning's episode had taken another two hours, so, counting all those back and forth travels and the research we did and hanging about that office and telling the same story over and over again, not to mention our efforts in educating the staff lacking in knowledge related to their core business, we likely clocked a full day altogether!

What is to be learned from this?

If you need a 4WD, Hertz should be your last resort!